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Proceedings of the Workshop on Commercialization and Transfer of Agricultural Technology in Africa

Accra, Ghana
November 4-7, 1996



Editors:
Bantayehu Gelaw
Consultant, Agricultural Technology Development and Transfer
Emmanuel Acquah
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USAID/AFR/SD/PSGE



Technical Paper No. 57
July 1997



***Productive Sector Growth and Environment Division
Office of Sustainable Development
Bureau for Africa
U.S. Agency for International Development***

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Foreword

In sub-Saharan Africa, agriculture is a major source of employment, income, and foreign exchange and offers opportunities to stimulate economic growth. Capitalizing on these opportunities requires modification in systems of technology development, transfer, and commercialization to improve productivity, efficiency, and applicability.

It is widely believed that substantial amounts of agricultural technologies that have been developed by the national agricultural research systems (NARSs) and the international agricultural research centers (IARCs) in Africa have not been transferred or commercialized. In response to this general belief, U.S. Agency for International Development, Bureau for Africa, Office of Sustainable Development, Productive Sector Growth and Environment Division (USAID/AFR/SD/PSGE) assembled a team of consultants — composed of an agricultural economist, an agricultural technology development and transfer specialist, and a food technologist — to visit representative countries in East and West Africa and submit an assessment report and a concept paper on the state of agricultural technologies developed, transferred, and commercialized in Africa.

A roundtable workshop of African and U.S. stakeholders was held at the University of Maryland Eastern Shore. Following the field assessment and the outcome of the roundtable workshop, an Africa-wide workshop on commercialization and transfer of agricultural technology was held in Accra, Ghana, November 4–7, 1996. More than 100 persons participated in this workshop, including representatives from a large segment of African technology development and transfer stakeholders. Among the stakeholders were African research and development institutions, IARCs, private agribusiness firms, nongovernmental organizations (NGOs), U.S. and African universities, and USAID field and Washington offices. The work-

shop was sponsored by the USAID/AFR/SD/PSGE and cosponsored with very strong support from the Ministry of Food and Agriculture of the Government of Ghana, with the collaboration of U.S. Department of Agriculture (USDA), University of Maryland Eastern Shore, and AMEX International, Inc.

The purpose of the workshop was to provide a forum for dialogue among African-based stakeholders in order to produce viable recommendations that national and international systems and donor communities could use to accelerate access to and use of agricultural technologies through commercial and noncommercial means. The workshop was divided into five thematic areas: 1) Enabling Environment, 2) Generation of Customer-Focused Technologies, 3) Sharing of Technologies, 4) Access to Inputs, and 5) Innovative Partnership Development. Several papers were presented covering different topics under each of the five themes in plenary sessions which were followed by extensive discussions in small group breakout sessions. The summary of the breakout group discussions were presented to the participants and were discussed further in plenary sessions. Participants identified major issues and offered recommendations to expedite the process of change.

This report covers two full papers from each of the five themes and abstracts of all papers presented during the workshop. I would like to thank all the participants for their time, effort, and valuable contributions which were instrumental in making the workshop a real success.

David A. Atwood, Chief
Productive Sector Growth and Environment Division
Office of Sustainable Development
Bureau for Africa
U.S. Agency for International Development

Glossary of Acronyms and Abbreviations

A&M	Agricultural and Mechanical
ADB	Agricultural Development Bank
AESA	Agro-Ecosystem Analysis
AFDB	African Development Bank
AFP	Actual Farmers' Practices
AFR	Bureau for Africa (USAID)
AIPO	African Intellectual Property Organization
ASARECA	Association of African Research for East and Central Africa
CFA	francophone African franc
CGIAR	Consultative Group on International Agricultural Research
CORAF	Conference des Responsables de Recherche Agronomique Africains (Conference for Representative of Agricultural Research in Africa)
CRSP	Collaborative Research Support Projects
CSIR	Council for Scientific and Industrial Research
DAE	Director of Agricultural Extension
DAS	days after sowing
DNA	Deoxyribo Nucleic Acid
ENV	Environmental Protection Unit (USAID/AFR/SD/PSGE)
ETP	extension test plot
FAO	Food and Agriculture Organization, United Nations
FAS/ICD	Foreign Agricultural Service/International Cooperation Division
FEWs	field extension workers
FFS	Farmers' Field Schools
FP	Farmers' Practices
FPP	Farmers' Production Plot

GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GGDP	Ghana Grain Development Project
GMO	Genetically Modified Organisms
GOG	Government of Ghana
GOT	Government of Tanzania
GOU	Government of Uganda
GR18, GR19	Most Popular Rice Varieties in Ghana
Groupements NAAM	Farmers' Associations of Burkina Faso
GSC	Ghana Seed Company
ha	hectare
ICRAF	International Center for Research on Agro-forestry
ICRISAT	International Crop Research Institute for Semi-Arid Tropics
IFDC	International Fertilizer Development Center
IFPRI	International Food Policy Research Institute
IITA	International Institute for Tropical Agriculture
INERA	Institute for Environment and Agricultural Research
INRA	Institute National de Reserche Agronomique
INTERCRSP	International Collaborative Research Support Project
IPR	intellectual property rights
ITA	Institut de Technologie Alimentaire
ITITAP	Institute for Technology and Industrialization of Tropical Agricultural Products
I2T	Ivorian Tropical Technology
KVMs	Kenya Vehicle Manufacturers
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MOA	Ministry of Agriculture
MOFA	Ministry of Food and Agriculture

NAES	National Agricultural Extension Service
NARF	National Agricultural Research Foundation
NARI	National Agricultural Research Institute
NARO	National Agricultural Research Organization
NARP	National Agricultural Research Project
NARSs	National Agricultural Research Systems
NCRE	National Cereals Research and Extension Project
NGO	nongovernmental organization
NMP	National Maize Program
OAU/STRC-SAFGRAD	Organization of African Unity/Scientific, Technical and Research Commission of Semiarid Food Grains Research and Development
OECD	Organization for Economic Cooperation and Development
PAN	Pesticide Action Network
PBR	plant breeders' rights
pdc	production-distribution-consumption sequence
PPA	Plant Protection Act
PPME	Program Planning, Monitoring and Evaluation
PSGE	Productive Sector Growth and Environment Division (USAID/AFR/SD)
PVPA	Plant Variety Protection Act
R&D	research and development
REDSO	Regional Economic Development Service Office
RELCs	Research Extension Linkages Committees
RTD	retired
SACCAR	Southern Africa Coordinating Center for Agricultural Research
SADC	Southern Africa Development Community
SAFGRAD	Semi-Arid Food Grains Research and Development
SD	Office of Sustainable Development (USAID/AFR)
SG 2000	Sasakawa Global 2000
SKD	semi-knocked down

SMSs	Subject Matter Scientists
SODEPALM	Oil Palm Development Company
SPAAR	Special Program for African Agricultural Research
SSA	sub-Saharan Africa
T&V	training and visit
TCP	Technical Cooperation Program
TDT	Technology Development and Transfer
TRIP	Trade Related aspects of Intellectual Property rights
UMES	University of Maryland Eastern Shore
USAID	U.S. Agency for International Development
USDA	U.S. Department of Agriculture
WARDA	West African Rice Development Association
WCA	West and Central Africa
WIPO	World Intellectual Property Organization
ZIMTRADE	Zimbabwe Trade

1. Opening Session

*Opening Address by the Honorable Commander S.G. Obimpeh (rtd), M.P.,
Minister of Food and Agriculture, Ghana*

Chair: Sam Dapaah, Chief Director, Ministry of Food and Agriculture, Ghana

The Honorable Commander S.G. Obimeh: Honorable Kumbirai Kangai, Minister of Lands and Water Resources of Zimbabwe; Honorable Johnson Nkuuhe, Uganda Member of Parliament; His Excellency the U.S. Ambassador to Ghana; Mr. Edward Brynn, Mr. David Atwood, Division Chief, USAID/Africa Bureau, Office of Sustainable Development; Mr. Myron Golden, Director USAID Mission to Ghana; Colleague Ministers of State; Excellencies; distinguished participants; ladies and gentlemen:

I wish, on behalf of His Excellency the President, the Government, and the People of Ghana and on my own behalf, to sincerely thank the U.S. Agency for International Development, Bureau for Africa, Office of Sustainable Development, for organizing this very important workshop on Commercialization and Transfer of Agricultural Technology in Africa and, more importantly, choosing to hold it in Accra, Ghana.

As part of the effort to make Ghana the gateway to West Africa, the Government of Ghana has put into motion a number of policies and strategies designed to make Ghana the first choice for tourists, businessmen, and conference organizers. I do hope, therefore, that the modest facilities placed at your disposal will satisfy your needs. However, do not hesitate to draw attention to any other requirements which will facilitate your deliberations.

Mr. Chairman, distinguished participants, the importance of this workshop lies in the fact that as we gradually but surely leave the 20th century and enter into the 21st century, it is important for African leaders, in consultation with their development partners, to produce viable and implementable strategies that can address the problems of commercialization and

transfer of agricultural technology to accelerate agricultural growth and, hence, help meet the social and economic development challenges of Africa in the 21st century.

It is noteworthy that this workshop is being held in Africa barely one

month after the Sasakawa Global 2000 sponsored a workshop on "Accelerating Rural Development in Africa: Forging the Political Commitment to Break the Cycle of Poverty," and the World Bank sponsored the Roundtable Conference on "Rural Well-being: From Vision To Action." Among the numerous important issues discussed were how to target poverty reduction, the problem of investing in social capital, the role rural roads play in promoting agricultural growth, opportunities, and problems associated with the world agricultural trade reforms, and the acceleration of rural growth in Africa.

One of the major recommendations made from these two conferences was that African countries need to reaffirm their political commitment to rural development through consensus-based strategies and poli-

In modern economic transactions, the consumer is said to be king, in that the consumer brings his needs to the international market place, and it is the job of private business, with the support of government, to satisfy these needs.

cies involving all stakeholders in the development process — i.e., the private sector, nongovernmental organizations (NGOs), traditional and nontraditional partners, and most importantly rural communities.

In Ghana, rural development has been a cardinal policy and the cornerstone of the Government's National Development Planning Strategy since the launching of the Structural Adjustment Program in 1982. In support of this policy, the 1992 Constitution mandates the Government to allocate at least 5 percent of its annual development budget directly to the 110 District Assemblies through the District Assembly Common Fund to finance their priority development projects.

Mr. Chairman, the key to rural development is sustainable agricultural growth and development. This workshop has therefore come at the most opportune time, since the development, commercialization, and transfer of agricultural technology are critical to the attainment of sustainable growth, poverty reduction, and economic growth.

I am informed that Africa continues to have one of the largest untapped agricultural potentials, and that through systematic commercialization and focused transfer of agricultural technology, this potential could be developed on a sustainable basis to the point where, in the 21st century, Africa could meet its food security needs and export its surpluses to the rest of the world.

In modern economic transactions, the consumer is said to be king, in that the consumer brings his needs to the international market place, and it is the job of private business, with the support of government, to satisfy these needs.

Unfortunately, in most African countries, the linkage between research and technology generation, on the one hand, and the commercialization and transfer of these technologies to satisfy the needs of the consumer, on the other hand, is either weak or nonexistent. If African countries are going to be successful in transforming their agriculture from subsistence farming into a highly productive and responsive sector of

their economies, it is imperative that they develop or acquire and adapt effective demand-driven, consumer-focused, and sustainable agricultural technologies that can be readily adopted by private sector entrepreneurs to commercialize agricultural outputs to meet the needs of the most demanding customer at competitive prices in the domestic, regional, and international markets.

Going through your rather extensive agenda, I am happy to observe that the themes to be covered during this workshop adequately address the issues of creating economic and social enabling environment, generation, and transfer of consumer-focused technologies, worldwide sharing of technology, and improving access to inputs markets. Other important issues also to be covered are identification and recommendation on ways to use innovative and other nontraditional approaches to effect efficient technology transfer and commercialization through partnership between and among nontraditional agents of development. It is my hope that, at the end of this workshop, you will emerge with implementable recommendations on how African countries can become effective participants in the international market place with the support of their development partners. In this regard, I would like the workshop to pay particular attention to how African countries can gain unrestricted access to the markets of their development partners in consonance with the aims and objectives of the World Trade Organization.

On this note, I wish to formally welcome my colleague Ministers from our sister African countries and all participants to our friendly country and hope that you will find time, in spite of the heavy schedule before you, to enjoy the proverbial Ghanaian hospitality. I am confident that, in the not too distant future, we will once again have the pleasure of your company in our country, as it is often said that no one visits Ghana only once.

With high expectation for the outcome of this timely workshop, I now have the greatest pleasure and honor to declare the workshop formally open. Thank you.

Remarks by His Excellency Edward Brynn, U.S. Ambassador to Ghana

H.E. Edward Brynn: Mr. Chairman; Honorable Minister of Food and Agriculture of the Republic of Ghana; Honorable Minister of Environment, Science and Technology, Ghana; Honorable Minister of Lands and Water Resources of Zimbabwe, Honorable Member of Parliament of Uganda; members of the Diplomatic Corps; representatives of the international, regional, and national agricultural organizations; ladies and gentlemen:

May I, on behalf of the United States Government, welcome all of you to this Workshop on Commercialization and Transfer of Agricultural Technology in Sub-Saharan Africa.

The objective of the conference is to initiate and stimulate a discussion on how to accelerate the transfer of appropriate and sustainable technologies among and within the African national research and development systems.

The U.S. Government recognizes the capability of Africans to generate and transfer technologies adapted to their specific needs and environments. It is in the light of this recognition that we are eager to collaborate with African national systems, such as the

Ministry of Food and Agriculture and the Council of Scientific and Industrial Research of Ghana, and their counterparts in the rest of sub-Saharan Africa, to examine the state of existing technologies with a view to facilitate the transfer and commercialization of appropriate technologies to the beneficiaries — i.e., small-scale farmers, small and medium enterprises, and community groups, all of whom are more often marginalized in technological development.

This is an African forum designed to enhance the transformation of agriculture so that it can serve as an engine for economic growth and development. My government's role is to serve as a facilitator to provide opportunities for National scientific workers and policymakers to chart the course of their national development efforts.

It is hoped that by the end of this workshop, some viable recommendations, particularly targeted toward small- and medium-scale agricultural operators could evolve to serve the objectives of this workshop.

This is an African forum designed to enhance the transformation of agriculture so that it can serve as an engine for economic growth and development. My government's role is to serve as a facilitator to provide opportunities for National scientific workers and policymakers to chart the course of their national development efforts.

Mr. Chairman, at this point, let me wish you a fruitful deliberation and successful workshop. Thank you.

Remarks by the Honorable Kumbirai Manyika Kangai, Minister of Lands and Water Resources, Zimbabwe

The Honorable Kumbirai Manyika Kangai: The Chairman; Dr. Sam Dapaah, Chief Director, Ministry of Agriculture, Ghana; the Honorable Minister of Food and Agriculture of Ghana; Mr. Myron Golden, Director, USAID Mission, Ghana; other workshop participants; distinguished guests; ladies and gentlemen:

I feel honored, Mr. Chairman, to be invited to say a few words on this topic of commercialization and transfer of agricultural technology in Africa at this very important workshop.

Mr. Chairman, I want to thank the Republic of Ghana for agreeing to co-sponsor and host this very important workshop. I also want to thank the United States Government through you, Mr. Ambassador, for sponsoring this workshop.

What I would like to do is go through, very briefly, our Zimbabwean experience and perhaps show you how important transfer and commercialization of technology is to my country.

When Zimbabwe gained independence in 1980, the agricultural sector was segmented into three distinct groups of farmers: communal farmers who practiced subsistence agriculture; commercial farmers; and state farming enterprises. We immediately introduced policies to eliminate the pronounced segmentation especially between the communal farmers and the commercial farmers.

A resettlement program was introduced where better quality land is purchased from the commercial farming sector and redistributed to farmers from the communal areas. Seventy thousand farmer families have benefited from this exercise. We also intensified extension services by reducing the farmer/extension worker ratio to 1:800 and made credit available for

the purchase of inputs, such as seeds, fertilizers, and chemicals. A tillage unit which charges fees below commercial rates was also introduced.

Agricultural output from the smallholder farmers had risen from 4-7 percent in 1980 to between 55-70 percent by 1992.

As in most other African countries, agriculture continues to be the most important sector of my country's economy. In other words, agriculture is the engine for the development of our economy. Approximately 75 percent of our total population derives its income from agricultural activities,

50 percent of the manufacturing industry is dependent, to some degree, on agriculture, and 46 percent of total exports are agricultural products. These figures are likely to continue to be so or even to increase in the future.

Consequently, agricultural technology development, transfer, and commercialization is going to be the lynch pin on which all our national development efforts will ultimately hinge.

In my country, research to generate technologies is undertaken by a governmental department, namely the Department of Research and Specialist Services, which is based in the Ministry of Agriculture. The country's four universities and a number of nongovernmental organizations complement government efforts in appropriate technology generation. The private sector organizations serve, to a greater extent, the commercial farming sector. In 1980, the focus of the Department of Research and Specialist Services was shifted towards putting greater efforts on developing appropriate production technologies in order to achieve food self-sufficiency and to uplift the standard of living of the majority of our people. However,

Consequently, agricultural technology development, transfer, and commercialization is going to be the lynch pin on which all our national development efforts will ultimately hinge.

a fall in the annual budget allocations to the Department has resulted in the scaling down of research activities. Thus, we are faced with the problem of slow adoption of available technologies and lack of funds to continue doing research.

Transfer of technology is the function of our Department of Agricultural Technical and Extension Services, which is complemented by a number of nongovernmental organizations and, to a certain extent, the universities.

I will just touch on a few of the numerous and seemingly insurmountable problems which we have identified in the field of agricultural technology development, transfer, and commercialization.

- Most smallholder farmers use cattle as draft power in some areas, while in others the farmers cannot afford even the low rates charged for tillage services. It should also be noted that only 50-60 percent of smallholder farmers own cattle, and some of those who have cattle do not have sufficient draft power. Some farmers use donkeys, but no suitable equipment for the use of donkeys has been developed.
- Fertilizers and agro-chemicals are expensive and difficult to access. Most smallholder farmers are located further away from input supply centers, which are mainly in the large towns. In addition,

rural areas are serviced by poor road infrastructure. Many traders shun operating in these areas. When they do, they charge exorbitant prices, thus resulting in inflated prices for the commodities which they sell.

- One of the most important constraints inhibiting the quick adoption of new technologies by smallholder farmers is the lack of working capital. Most of the credit which has been granted to them has been short-term credit for the purchase of seasonal inputs. This has resulted in little development in terms of infrastructure and other long-term investments which are necessary to maximize productivity.
- In horticultural production, which a number of smallholder farmers have tried to enter in recent years, the problems have mainly been in the areas of post-harvest processing, packaging, and marketing. These problems have made it difficult for the farmers to enter the lucrative export market.

I note with great satisfaction, Mr. Chairman, that all these problems will be addressed in one way or another by the speakers who will come after me. It is my hope that some useful recommendations to solve these problems will be made at the end of the workshop. I thank you.

Comments by Mr. David Atwood, Division Chief, USAID/AFR/SD/PSGE

Dr. David Atwood: Honorable Ministers; Honorable Member of Parliament from Uganda; Mr. Ambassador; representatives of international, regional, and national organizations; representatives of private firms and NGOs; Mr. Chairman; ladies and gentlemen:

It is a privilege and an honor to address this group with such a wealth of experience in technology development and transfer in Africa.

You came here, all of you, as participants or observers of technology development and transfer (TDT). I would venture to say that every one of you has seen successful TDT improving the lives of African farmers and consumers. But also, you have seen failures, lost opportunities, serious needs unmet through lack of use of good technologies.

Private firms have advantages such as strong staff, solid knowledge of the market, and ability to respond quickly to new opportunities. But they also face problems in sourcing technology internationally and problems in reliable partnership arrangements with National Agricultural Research Systems (NARSs) to source technology in their own countries.

NGOs and extension agencies have strengths in extensive field presence and knowledge of farm conditions, but also face limited impact and limited partnership with NARSs.

The National Agricultural Research Systems do realize the contributions research has made through the skills of their highly scientific staff. They have lived through many difficult years with pressure on staff and research budgets and with the inability to measure and prove the impact of their research, even though they knew it has had positive impact.

The other problem has been their weak constituencies, at home and among donors. Despite these difficulties, agricultural research has had some positive effects. African research leaders have sought new ways to respond to their financial problems. In so

doing, they have gone beyond financing problems to address fundamental problems of broad interest to all of us in TDT. They have developed national and regional strategies and framework for actions with the help of SPAAR.

They have, very rightly, re-examined the entire technology development system, not just the

staffing and resource problems. The results from these experiences have led to much stronger systems of technology development, based on:

- sustainable financial mechanisms, often in partnership with private sector;
- reform of personnel and budget systems;
- clear problem identification and priority setting, instead of doing a little of everything;
- regional coordination;
- cooperation by different countries on common research programs;
- rigorously measuring research impact and communicating it; and
- demand-driven technology development with a key role for farmers, private firms, and NGOs in partnership with NARSs.

This agenda is not yet completed, but future directions are clear.

Private firms have advantages such as strong staff, solid knowledge of the market, and ability to respond quickly to new opportunities. But they also face problems in sourcing technology internationally and problems in reliable partnership arrangements with National Agricultural Research Systems (NARSs) to source technology in their own countries.

In a sense, the process leading up to this workshop has resulted from the experiences of the NARSs over the past few years. Many of us, including those at USAID, now see the problem of technology development and transfer as a much broader issue than we did a few years ago, and believe that the concepts of commercialization, generation of demand-driven technology, and partnerships between a broad range of private and public institutions have broadened the technology development and transfer process.

I would like to step back and say just a bit about USAID support for TDT here. We have supported and drawn inspiration from the SPAAR Framework for Action for Africa. The Africa Bureau has initiated and supported a number of programs including:

- eight regional research networks (maize, sorghum, rice, cowpea, cassava, beans, potato, and agroforestry);
- InterCRSP natural resources management program in West and Central Africa;
- policy analysis and strategic planning in East Africa;
- impact assessment and sub-sector economic analysis in West and Central Africa; and
- program development and institutional reform (ASARECA, CORAF, SACCAR, INSAH).

Let me also say something about the importance USAID puts on agriculture, TDT, and food security issues. Some of you know that U.S. support for agricultural activities has declined over the past few years. The head of the USAID just presented a proposal for new funding for food security in Africa to the Administration's budget office. We do not know the ultimate outcome, due to continued pressure on the overall U.S. budget, but we do know that this has put agriculture back on the agenda in USAID, with greater support to the international research centers which have been reduced in funding over the past several years. We hope that USAID support to agricultural technology will be substantially higher this year than that of last year. The food security initiative will address food security in its broadest sense.

This workshop is part of the broader thinking to examine technology commercialization and transfer

issues among African stakeholders in order to produce viable recommendations and guidance that national, regional, and international systems and donor communities can use to accelerate the transfer and commercialization of agricultural technologies.

The workshop will focus on topics crucial to the commercialization of agricultural technologies, including:

- creating an enabling environment and processes for effective commercialization and transfer;
- generating demand-driven and customer focused technologies;
- creating mechanisms for facilitating the sharing of technologies;
- improving the development, access, and delivery of agricultural inputs; and
- developing mechanisms to generate local resources through new and innovative partnerships, particularly with non-traditional partners such as the private sector, NGOs, and community groups.

This workshop is part of the broader thinking to examine technology commercialization and transfer issues among African stakeholders in order to produce viable recommendations and guidance that national, regional, and international systems and donor communities can use to accelerate the transfer and commercialization of agricultural technologies.

The experiences you bring to this workshop to share with us will contribute greatly to its outcome.

Our challenge here, echoing the comments from Ghana's Minister for Food and Agriculture and the U.S. Ambassador, is to come up with implementable recommendations. This is not a long list of actions, but rather identification of workable partnership arrangements between public and private sectors which are needed to accelerate the ways in which our technology, knowledge, skills, and resources could be of immediate help to farmers and consumers. Thank you.

Statement by Bamidele F. Dada, Assistant Director General and FAO Regional Representative for Africa

Bamidele F. Dada: Mr. Chairman; Honorable Ministers; Members of Parliament; Excellencies; the U.S. Ambassador; distinguished participants; ladies and gentlemen:

It is an honor and a real pleasure for me to address this important meeting on behalf of the FAO Director General, Dr. Jacques Diouf.

The theme of the workshop is timely and appropriate for the simple reason that Africa has not benefitted much in the past from the tremendous advances of agricultural science and technology. While the Green Revolution technologies developed in the 1970s were instrumental in averting the food crisis which affected hundreds of millions of people in Asia and elsewhere, the same impact was not realized in agricultural production in Africa.

The adoption of available technologies for food security largely depends on the incentives farmers perceive from them, and incentives are linked to markets. This is a clear indication that technology application is not entirely governed by biological and biophysical determinants but, in many instances, by the political commitment, economic policies, infrastructures, and markets.

Studies have indicated that technologies to produce enough food to feed the population of our planet are available at national, regional, and international levels, but these technologies have not contributed to solve food problems of the millions of people in Africa and elsewhere. This is a clear indication that technologies need accompanying measures to be

adopted by farmers. As you are aware, there is no one standard farmer in Africa but a multitude of farmers with their specific problems.

In its effort to assist member countries overcome hunger and malnutrition, FAO is currently sponsoring a program on technology assessment and transfer, involving many countries in the region. This undertaking involves national partners including research

institutions, universities, extension services, the private sector, farmers' organizations, and nongovernmental organizations. Four countries — namely Ghana for west and central Africa, Senegal for the Sahelian countries, Uganda for the highlands, and Zimbabwe for Southern Africa — had been selected as case studies to carry out surveys for data collection for technology

assessment. The surveys were followed by national expert consultations on technology assessment and transfer which were successfully organized by national agricultural research systems. A Regional Expert Consultation on Technology Assessment and Transfer is due to be held in 1997 to exchange experiences and set priorities based on three identified groups of technologies.

Mr. Chairman, as you are aware, this workshop is taking place on the eve of the World Food Summit which is being convened in Rome next week. I would therefore like to seize this opportunity to make a few remarks on this historic event.

The situation of food security in most developing countries, especially in sub-Saharan Africa, remains disturbing. While developed countries have attained

The adoption of available technologies for food security largely depends on the incentives farmers perceive from them, and incentives are linked to markets. This is a clear indication that technology application is not entirely governed by biological and biophysical determinants but, in many instances, by the political commitment, economic policies, infrastructures, and markets.

a reasonable measure of food security for their people, for us in Africa, the food security situation of our populations remains insecure. The incidence of hunger and malnutrition continues to spread, and poverty is inflicting untold suffering on our people. As we approach the 21st century, it is unacceptable for some people to have food in abundance while others go to bed hungry.

These considerations influenced the decision of the FAO Director General to convene the World Food Summit in Rome from November 10-17 this year. FAO member countries have given their unanimous approval to this proposal, and we have been greatly encouraged by the active moral and political support the Director General's proposal has received from Heads of State and governments of African countries. This is appropriate since, for us in Africa, the Summit provides a unique opportunity to voice our concerns, strategies, and goals for achieving sound agricultural development and national food security in a sustainable environment, and we expect to receive sympathetic understanding and favorable response from the international community.

The Summit is intended to provide a forum at the highest political level to address the need for global commitment and action to redress the most basic problem of food security. It is expected to lead to the adoption of appropriate policies and strategies at international levels, as well as a plan of action for implementation by all parties concerned: governments, international institutions, and all sectors of the society.

Since it will be a world summit, it will have a global perspective in dealing with all aspects of food security and will address the root causes of hunger and malnutrition in all parts of the world, while at the same time incorporating the specific regional dimensions of the problems and their solutions.

Mr. Chairman, ladies and gentlemen, FAO will spare no effort to help make the historic World Food Summit a true milestone in the pursuit of the most fundamental of human rights for all our people at all times: the right of access to sufficient food. Thank you.

2. Plenary Session I

Chair: Paddington Zhanda, Chairman, ZIMTRADE, Zimbabwe

Rapporteur: J.B. Mubiru, Director of Agricultural Extension, Uganda

Transfer of Agricultural Technology Through Commercialization: Critical Issues for the 21st Century by Emmanuel T. Acquah, Professor of Agricultural Economics and Director of International Programs, University of Maryland Eastern Shore (UMES) and Bantayehu Gelaw, Consultant, Agricultural Technology Development and Transfer (TDT), McLean, Virginia, USA

To fully understand the process and status of agricultural technology development, transfer, and commercialization in sub-Saharan Africa, it is necessary to understand the agriculture and food systems and types of institutional supports and their influence on the development of agriculture. For the purpose of this paper, agriculture is defined as a system which integrates the input, production, marketing, and post-harvest components.

The first component of this system (land, labor, capital, and management) is represented as the “Resource” sector in the model. The second component is identified as the “Production” sector, and it includes the “Input, Production, and Marketing” sub-sectors. The “Input” sub-sector includes all firms that produce and sell goods and services (e.g., tools, equipment, seeds, fertilizers, pesticides, credits, and other commodities) used in growing crops and raising livestock. The “Agricultural Production” sub-sector includes all the firms or farm-firm households that grow crops and raise livestock. The “Processing/Marketing” sub-sector includes exchange and distribution systems and facilitating functions that create form, place, time, and possession utilities. The third component of the model is the “Institutional Support” sector, which provides national and local policies, infrastructure, and administrative services to support the operations of the other two sectors of the model.

The action of a unit in a sector of the model may cause inter-unit reactions and, subsequently, influence the conduct of the whole sector. The decisions/actions of a sector could also create inter-sectoral and intra-sectoral behavioral changes and responses as

well as inter-unit reactions. It is through such economic behavioral changes and reactions of small-medium enterprises and the farm-firm households that economic empowerment could be attained in the agricultural sector of most African economies.

For our purpose, technology transfer is defined as the different processes of introducing a new technology to the targeted end-users, for which the technology was developed. In Africa, this has traditionally been done by agricultural extension services and some input companies. However, there is evidence that researchers have assumed some significant roles in limited transfers of some technologies (i.e., farming systems type adaptive studies).

Commercialization of agricultural technology would, therefore, encompass widespread distribution, adoption, and acceptance of a given technology by key actor(s) in the input, production and/or post-harvest sub-sector(s) of the food and agricultural systems, as well as sustainability and contribution to social values. Commercialization should not necessarily be restricted to profit making operations, the sustainability of a product and its contribution to social values in producing self-sufficiency should be taken into consideration when defining commercialization. There are, however, a number of questions that need to be answered in order to facilitate the transfer and commercialization of agricultural technologies. They include, but are not limited to:

- What research, policy, and regulatory barriers in the institutional support sector hinder the transfer and commercialization of developed technology?

gies in Africa, and how can new technologies be developed and translated into market-oriented and profitable products?

- What are the elements of the input and post-harvest/marketing sub-sectors that greatly influence commercialization of technologies?
- What are the essential linkages and conditions that facilitate the transformation of technologies in the production sector for economically viable ventures?

To stimulate technology commercialization, there needs to be an understanding of:

- the dynamics of the essential factors that link the sources of technology (manufacturers, financiers, marketing agents, and end-users) in the input sub-sector markets;
- formal and informal barriers that inhibit efficiency in the flow of inputs from one sub-sector to another;
- factors that lead to the transformation of a technology into viable, profitable enterprises and value-added commercial products;
- how the intermediate processes that transform technologies into value added commercial products are integrated/linked and organized to respond to market realities and opportunities;
- the ways and means of establishing unique partnerships between public and private sectors to invest in commercializable technologies; and
- the policy and regulatory environments that influence licensing, financing, and marketing of products.

Figure 2.1 shows that there are several agents and individuals (multiple players) in agricultural technology development, transfer, and commercialization. In the “Resources” and “Production” sectors of the model, the key players are private individuals or households. The key players in the “Institutional” sector are government organizations and NGOs with potential for private individual participation. The interplay between the “Institutional” and “Resources” sectors of the model is essential for the development of ap-

propriate technologies, while collaboration between the “Institutional” and “Production” sectors influence the transfer and commercialization of developed technologies. It is, therefore, imperative to create mechanisms for developing new partnership initiatives among private individuals, firms, government organizations, and NGOs for domestic capacity building to stimulate the development, transfer, and commercialization of agricultural technologies.

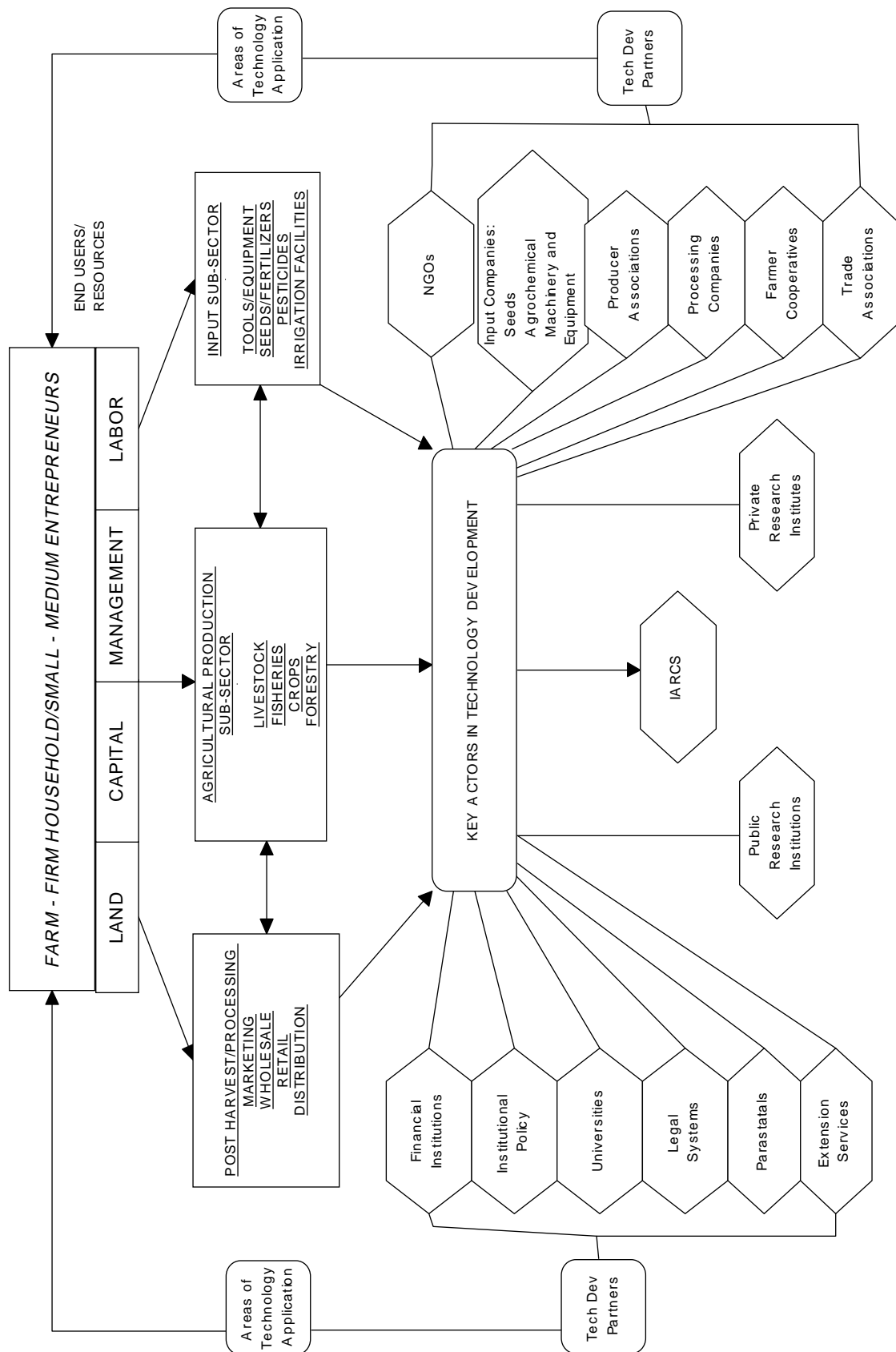
Agriculture is the major source of employment, income, and foreign exchange in most SSA countries and, therefore, could serve as the pivot for economic growth. The potential for growth lies in improved agricultural productivity and efficiency in the food systems. The improvement depends on advances in technology, which depend on the institutional frameworks for developing the appropriate technologies and the mechanisms for their transfer and commercialization. In SSA, the development of sustainable and viable agricultural systems is expected to occur in complex and difficult conditions including:

- an environment made fragile from degradation;
- food insecurity made high from rapid population growth and drought;
- an ever-growing urbanization, with massive net out-migration;
- competitive economic systems that compel agribusinesses in developing countries to compete with counterparts from other parts of the world;
- vast inequity in wealth distribution with an increasing number of “marginal producers”; and
- weak economic systems with low economic and human capital endowments.

Economic growth and development require productivity increases in all the sub-sectors (input, farm, and post-harvest) of the “Production” sector of the food and agricultural systems. Requirements for such increases include:

- significant improvements in the input sector, coupled with improved management practices to stimulate increased productivity in technical agricultural production;

Figure 2.1. A Diagnostic Plan for Agricultural Technology Development & Utilization System



- increased efficiency in transportation and distributions;
- improved infrastructural packaging and marketing skills;
- expanded utilization of food crops; and
- new product development technologies that will add value to products for both internal and external markets.

Transforming the agricultural and food systems into engines of economic growth requires modified systems for technology development, transfer, and commercialization in most of SSA countries. However, this transformation will be difficult at a time when the traditional machineries for technology development and transfer (NARSs/government extension systems) are having serious financial problems. For example, there has been a massive erosion of budgets allocated to most NARSs over the last 10 years, with most of them spending up to 90 percent of their budgets on salaries and only about 10 percent on operations and maintenance of physical plants and infrastructure.

Agricultural research and technology development and adoptions in SSA have been supply-driven, without useful participation of end-users (farmers, input business, and processing firms) and transfer agents (extension officers). This has led to numerous cases of technologies developed, but not transferred or adopted. Too often, supply-driven technologies are not appropriate for the resource-poor end-users. Therefore, what is required is a more demand-driven process that would ensure appropriate technology development, transfer, and commercialization.

Research and extension workers traditionally have focused on providing information and inputs to producers of export crops rather than food crops, with the information disseminated “top down” to male farmers while neglecting women, who do most of the production work. Furthermore, communication between and among researchers, extension agents, and farmers has been inadequate and has led to the lack of appropriate and profitable technology transfer. In cases where innovative advances have been made, lack of access to credit and availability of required inputs for

effective application of new technologies have deferred the adoption of such technologies. What may be required, therefore, is the participation of a greater number of the players in the process of technology development, transfer, and commercialization.

To transform SSA’s agricultural systems to serve as engines for economic growth in the 21st century, we believe that the following are some of the critical issues that need attention. The topics crucial to commercialization and transfer of agricultural technologies are presented below.

CREATION OF ENABLING ENVIRONMENT

This includes the identification of policies, institutional, and infrastructural constraints and opportunities that affect the transfer and commercialization of agricultural technologies and suggest how the constraints could be relaxed and opportunities exploited. Here we should pay particular attention to policies that lead to implemented technologies. According to Brenner (1993), implemented technology is that which is actually used in production. The spectrum of activities between the frontier of available technology and implemented technology reflects the economic environment. Implementation typically reflects the process of seizing the incentives and reducing constraints that are derived from the underlying economic condition with which producers are faced in making technology choices. The goal is to provide an enabling environment that helps address the activities between “implemented” and “available” technology.

The ability to efficiently choose a technology depends critically on agricultural policies, level of investment in human capital, and the transformation of the institutions needed to realize the full productive potential of new technologies (OECD, 1992).

As traditional agricultural policy concerns (such as inadequate farm household income) become less relevant, an upsurge in public and rural development issues will present a number of challenges for policy-making. Economic research is needed to identify the trade-offs between agricultural productivity, natural

resource use, protection and environmental quality, and the design of appropriate policies to deal with these issues. Agricultural policies and technological change should be addressed through systematic analysis if the relationships among agricultural and rural development and the environment are to be maintained.

Policies need to be flexible in order to adapt and adjust to the consequences of changing technologies to enhance the efficiency and productivity of the agribusiness sector and to ensure that the benefits of technological changes are shared broadly among producers, consumers, and taxpayers.

GENERATION OF CUSTOMER FOCUSED TECHNOLOGIES

The challenge here is the ability of national systems to determine approaches for generating demand-driven, customer focused, and sustainable technologies. While increased public/private sector interactions may lead to maintaining investment in research, it may also lead to changes in research priorities in the future. However, there is still an important role for public research in fulfilling social goals, such as providing improved varieties for resource-poor farmers, conserving genetic resources, or conducting basic research.

The introduction of new technologies may necessitate changes in cultural and management practices, and institutional arrangements could play an important role in promoting necessary complementarities between the public and private sectors in generating technologies. In order for demand of new technologies to be translated into supply, public and private institutions must make critical decisions regarding institutional mix and interactions in the process of technological change. Because market failures may, in some cases, lead to an under-supply of new agricultural technology, careful attention must be given to the comparative advantage of the public and private sectors in order to harness fully their complementarities and exploit synergy.

INFORMATION SHARING AND DISSEMINATION

African countries can accelerate agricultural technology transfer and commercialization through information sharing and dissemination. Telematics will be critical in enhancing the transfer and commercialize technologies. It is imperative that the SSA countries do not allow themselves to be left behind on the information super highway. They should take advantage of telematic opportunities like AfricaLink, Trade Net and, more recently, the U.S. Government-funded Leyland Initiative.

To be effective partners in trade, SSA countries should be prepared to participate in regional trade regimes and especially in World Trade Organization meetings.

INTELLECTUAL PROPERTY RIGHTS PROVISIONS

The internationalization of the economy, coupled with a cooperative pattern of research and development processes, necessitates the adoption of clear cut rules for ownership and economic returns to the various players in the business of developing technologies. National innovativeness contributes to technological progression if it is matched by legal security and protection of inventors, innovators, and investors. One of the major issues that contributes to the stimulation of invention and innovation is intellectual property rights. Revisions in intellectual property protection are necessary to cope with shifts in the technology paradigm, in order to promote economic growth and competitiveness. For these reasons, the protection of intellectual property rights, along with the promotion of technology transfer and issues of unfair competition, will receive increasing world-wide attention, especially after the conclusion of the agreement on Trade Related Aspects of Intellectual Property Rights (TRIP) including trade in counterfeit goods of the Uruguay round of the General Agreement on Tariffs and Trade (GATT) signed in Marrakesh, Morocco on

April 15, 1994, establishing the World Trade Organization (WTO).

Researchers and research institutions in Africa need to protect their intellectual property from piracy and unjust use of the technologies developed by them. Dissemination of research results requires good intellectual property policies which can provide protection from unethical exploitation. An effective intellectual property policy allows employees of the research institutions to share in the economic gains of their invention.

Innovations and technological know-how are the life blood of any nation. Africa is, therefore, duty bound to take deliberate measures to strengthen its technological capacities in order to uplift the standard of living of its people. This could be attained through strengthening of the African Regional Industrial Property Organization (ARIPO) based in Harare, Zimbabwe and the African Intellectual Property Organization (AIPO) based in Yaounde, Cameroon.

ACCESS TO CRITICAL INPUTS

Availability and access to credit by small and medium scale farmers and businesses will continue to be problems that will require attention. The development of sustainable formal and informal rural financial institutions will be critical to successful technology transfer and commercialization in rural areas.

Entrepreneurship and management must receive more attention if efforts to commercialize agriculture are to succeed in SSA. Two areas that require effective management skills are the management organization of public research institutions and management of small and medium businesses. Agribusiness management skills will have to be intensified in vocational, technical, and tertiary educational systems.

One major constraint to the transfer and commercialization of agricultural technologies in the farm production sector is weak support infrastructure, especially the mode of transportation. Reliable modes of transportation that can handle heavy volumes of outputs and inputs are critical for efficient input sup-

ply, volume of production, and marketing of farm produce.

Despite its fundamental importance in agricultural technology and productivity, the seed/planting material sector remains a relatively unexplored area of research. Until recently, the seed requirements of small farmers in most SSA countries have been almost entirely overlooked in national strategies.

Although they represent a larger portion of the total number of producers, small-scale semi-commercial farmers still account for a relatively small share of the total market for improved seed. To accelerate the commercialization of improved seed varieties for different agro-ecological regions, the issue of seed industry development will need more attention.

INNOVATIVE PARTNERSHIP INITIATIVES

Active participation of key stakeholders in agricultural development is expected as we move into the 21st century. It will be necessary to identify and recommend non-traditional and innovative approaches to technology transfer and commercialization through partnerships between and among traditional and non-traditional agents of development. The roles of the private sector and nongovernmental organizations are expected to increase and complement the efforts of government agencies and the donor community in transferring agriculture.

Figure 2.1 indicates the scope of the key players in technology development, transfer, and commercialization. In the area of technology transfer, recent events have shown that the private sector (firms, NGOs, farmer associations, etc.) plays a significant role in the transfer and commercialization of agricultural technologies (Acquah and Gelaw, 1996; Tripp and Gisselquist, 1996; RANDFORUM, 1995). These developments suggest the need for new partnership initiatives that include the public sector, NGOs, the private sector, and donor communities, for new approaches to stimulate agricultural technology development, transfer, and commercialization and trans-

forming the food and agricultural systems into engines of economic growth in SSA.

There is a broad consensus that there is a role for government in research to the net benefit of society as a whole. Whether this potential can be realized depends on the government's ability to intervene in ways that benefits outweigh costs. This consensus primarily resides on the broad aspects of Research and Development (R&D).

Perhaps the most persuasive case for the public-sector involvement in the funding of R&D is when the benefits are diffused among a wide variety of people with no possibility of charging separately for these benefits.

Agricultural R&D has a number of characteristics which may cause market failure and result in under investment. The most common argument suggested as giving rise to market failure, and thus advocating government intervention in research, is its "public good" attributes.

Some typical examples of the types of spillover benefits which might arise from agricultural R&D include:

- the diffusion of the resulting new knowledge throughout the economy;
- generation of social benefits to downstream industries in the form of lower input prices, which in turn reduces costs of production (this is the productivity effect of embodied spillovers); and
- spillovers embodied in new products and processes if their price to user industries or consumers is below their social value (OCED, 1991; 1992).

If agricultural research were left entirely to the private sector, the result could be a bias in the allocation of research resources towards those areas of highest profitability. Other areas important to environmental protection, farming practices, and management might be neglected.

While there are strong *prima facie* arguments for government intervention to support agricultural R&D, there are many ways in which governments can intervene to address market failures in agricultural R&D. These might include providing special property rights through patent legislation and laws on intellectual property; encouraging or facilitating collective action to fund research; providing tax incentives; funding higher education research; and providing grants (Curran and Podbury, 1994).

Governments have a number of other policy instruments with which to influence the private sector's technological activities. The public sector can foster private sector research through joint ventures, where both sectors jointly undertake and/or co-finance a program of research. In addition, as private firms may spend too little or too much on innovation, generate innovations too early or too late, or too similar or too different. The government has an important role of identifying the particular market failure and ensuring an optimal allocation of agricultural R&D.

Perhaps the most persuasive case for the public-sector involvement in the funding of R&D is when the benefits are diffused among a wide variety of people with no possibility of charging separately for these benefits.

Broadly speaking, the efficiency of the research system could be improved if public funding for R&D is undertaken only where:

- the nominal benefits to the society as a whole are expected to be greater than the cost, including administration costs;
- the research would not be undertaken by the private sector; and
- public funding is the least cost method of overcoming market failure (Curran and Podbury, 1994).

Nevertheless, the role of government is likely to evolve over time with changes in the economic environment.

It is hoped that the workshop participants would explore plausible mechanisms for addressing the six challenges raised in this paper and recommend prag-

matic approaches for dealing with them to accelerate the transformation of agriculture in SSA through the transfer and commercialization of technologies.

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Technology Frontiers and Agricultural Transformation in Sub-Saharan Africa by Mywish Maredia, Visiting Assistant Professor; Julie A. Howard, Visiting Assistant Professor; Laura Farrelly, Former Graduate Research Assistant; Kei Kajisa, Graduate Research Assistant; Duncan Boughton, Former Visiting Assistant; Lawrence Rubey, Former Visiting Assistant; James Shaffer, Professor; and James Oehmke, Associate Professor. All are in the Department of Economics, Michigan State University, Michigan, USA

INTRODUCTION

Except in maize and a few export crops, science-based technology has had a limited impact on agricultural productivity in Africa. Whether Africa's "technology gap" results from a lack of techniques, or the failure of farmers and other users to adopt available techniques, is a highly debated issue. This question has important implications for agricultural research resource allocation, i.e., how much emphasis African countries should devote to strategies that push the technology frontier further (the availability argument) or close the technology gap by easing physical, economic, and social barriers to technology adoption (the adoption argument) to meet the challenge of increasing agricultural productivity. This paper argues that availability and adoption are both important and develops a paradigm to illustrate how improvements are needed in the whole "system" rather than the "engine" of technical improvements alone to get agriculture moving in sub-Saharan Africa.

TECHNOLOGY FRONTIER AND AGRICULTURAL TRANSFORMATION: A CONCEPTUAL FRAMEWORK

The process of agricultural transformation requires: technical innovations throughout the system, not just on-on-farm; integration of technical innovations with changes in the environment (i.e., policies, organiza-

tions, human capital, and infrastructure related to extension, input and output markets, processing services, and consumption); and coordination of these innovations and changes between different stages of the agricultural system. The state of the art in these three areas is the technology frontier.

Closing the technology gap and shifting the technology frontier further is a continuous process of generating new techniques, providing an enabling environment, and coordinating the different stages of the agricultural system.

Closing the technology gap and shifting the technology frontier further is a continuous process of generating new techniques, providing an enabling environment, and coordinating the different stages of the agricultural system.

The agricultural system is viewed as a production-distribution-consumption sequence (PDCS) of physical transformations linked through transactions

(Boughton et al., 1995) (Figure 2.2). Each of these physical transformations is governed by a production function that relates inputs to the output. Facilitating structural transformation requires increasing the productivity of the agricultural system's PDCS. This can be accomplished by striving toward an existing technology frontier or shifting the technology frontier further. Which of these strategies (closing the technology gap or pushing the frontier further) will be most effective is country and commodity-specific, and depends on the position of the country and commodity sector relative to the technology frontier. Increased productivity can be achieved in three ways:

1. improving the techniques in each of the individual transformations that shift the production functions upwards (e.g., through improved seeds, agronomic practices, harvesting, storage, and processing techniques);

2. improving the environment that allows the realization of potential gains from technical advancements (e.g., timely and adequate supply of inputs, credit, access to markets, infrastructure); and
3. improving the coordination between advancements in the technical frontier and the environment across different physical transformations (e.g., coordination between the development of improved cattle breeds that are more efficient in transforming feed, increased supplies of feed, and production contracts that facilitate the sale of increased milk and meat output) (Boughton et al. 1995).

STRATEGIES TO OVERCOME THE TECHNOLOGY GAP

Effective strategies to close the technology gap should be based on improvements in techniques, environment, and coordination mechanisms, i.e., on technical as well as institutional solutions. A country could use four different options to advance technically:

1. import/purchase techniques directly from a leader;
2. adapt existing techniques to the local environment, following local testing and screening;
3. generate new techniques through inventive adaptive research that uses the knowledge underlying a technique developed by a leader (this option requires the follower to have substantial research and development capabilities); and
4. leapfrog the leader by engaging in original research to overtake and make the current leader's innovations obsolete (this requires a highly capable and competitive R&D team and a long-term financial commitment by the government or private sector).

The optimal choice between these options will depend on the environment (e.g., the country's stage of transformation, organizational capacity, human resources) and on the "technique by environment" interactions. Each option to close the technical gap needs to be complemented by appropriate measures

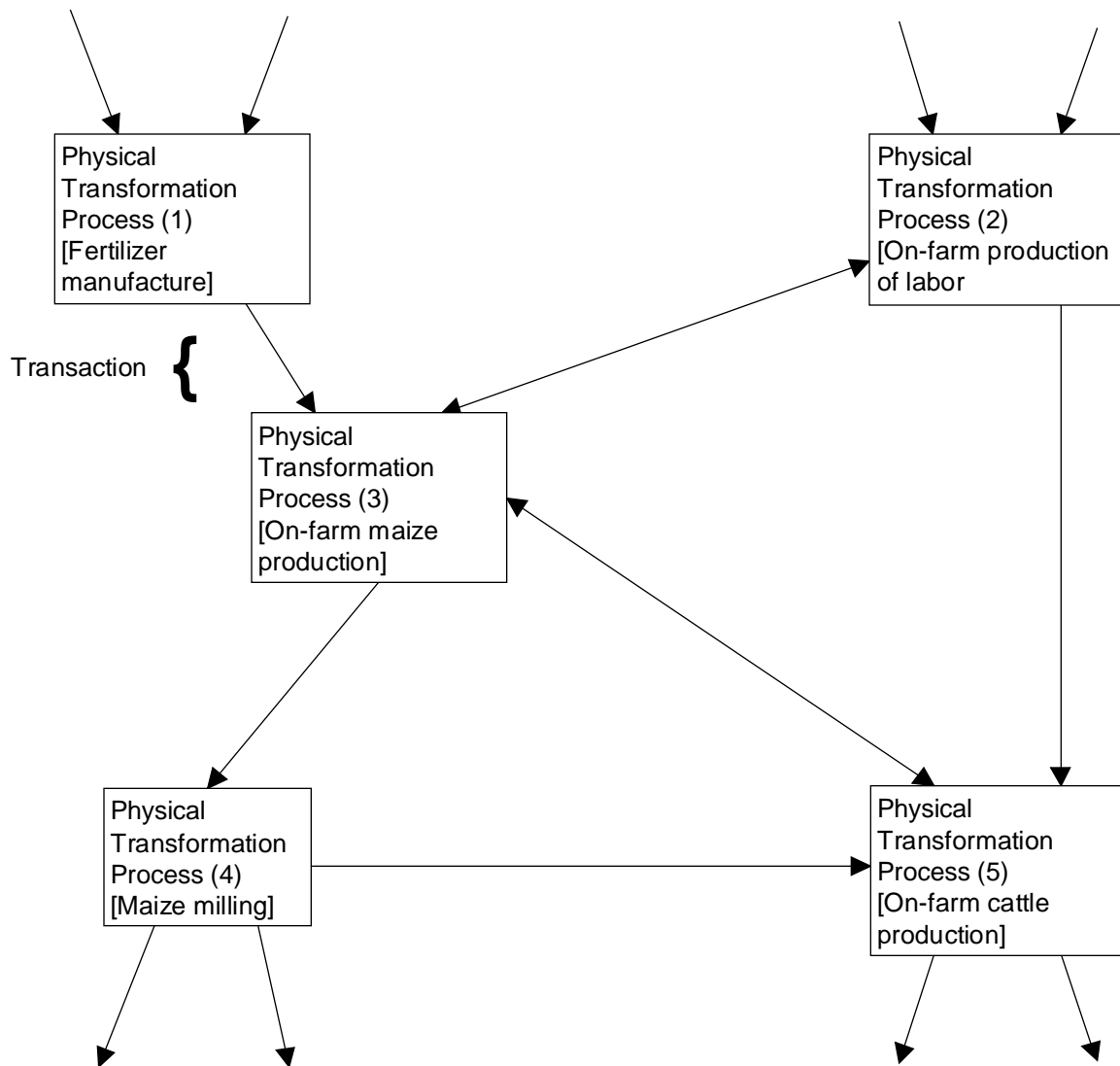
to close the "institutional gap." These include general policies (affecting price, trade, and monetary and fiscal systems) and specific laws and regulations (concerning business development, intellectual property protection, environmental protection, etc.) that affect decisions to import techniques and invest in adaptive or inventive research. The specific strategy to close the technology gap and the relative importance of technical versus institutional innovations will differ according to the commodity and the stage of the agricultural system (e.g., input distribution, on-farm production, processing, and marketing of outputs).

WHERE IS SUB-SAHARAN AFRICA IN RELATION TO THE TECHNOLOGY FRONTIER?

The advancement in technology frontiers over time has resulted in continuous shifts in the production possibilities frontier worldwide. Most of the upward shifts have been incremental, arising from improvements in one or several technical and institutional components (e.g., crop rotations, soil protection, land tenure arrangements). However, in special cases, technology advances have produced dramatic shifts in the production possibilities frontier, including hybrid seed technology, the improved seed and fertilizer based Green Revolution, and agricultural biotechnology. Such dramatic shifts in the technology frontier have increased the technology gap between crops and regions because of differences in the physical and institutional environments affecting the adoption of these technologies.

The current level of adoption of techniques in Africa does not approach the gains realized elsewhere with Green Revolution technology, hybrid seeds and biotechnology. The current low use of improved seed, fertilizer (10 kg/ha on average in Africa, compared with 65-216 kg/ha in Latin America and Asia), and irrigation (4-6 percent of cropped areas in Africa, compared with 40 percent in India and 60 percent in Indonesia), suggests that much of African agriculture is operating at traditional or semi-traditional technology levels.

Figure 2.2. Nodes in a Production-Distribution-Consumption Sequences (PDCS)



Each node in the PDCS represents a physical transformation process that combines two or more inputs (which are themselves outputs from “upstream” transformation processes) to produce an output. This output serves as an input to subsequent “downstream” transformation processes. The nodes in the system are linked by transaction, which can take place either within a firm or between firms (e.g., through markets). Examples of physical transformation processes are shown in brackets.

Source: Boughton et al. (1995)

Observers have offered many explanations about why it has been difficult to replicate the success stories of the Green Revolution and other technological advancements in Africa. These include agroclimatic differences (less fertile soil, a much smaller proportion of irrigated land, highly variable rainfall), complex farming systems (fallow systems, mixed cropping patterns), the small size and ecological diversity of countries, the short history of research on Africa's traditional cereals and root crops, labor constraints, poor infrastructure, and lack of institutions that generate and facilitate the transfer of techniques to end-users.

The widespread gap that exists between the potential yields obtained in controlled trials on experiment stations and farmers' fields across commodities confirms the importance of improving the environment for farm-level physical transformations. However, the closing of this gap is unlikely to result from any single technique in isolation, but will require an additive approach that builds on the complementarities of technical and institutional changes at various levels of the agricultural system, including the research and extension system, input delivery system, farm-level production, processing, and marketing.

TECHNOLOGY FRONTIERS IN DIFFERENT STAGES OF THE AGRICULTURAL SYSTEM

Technical and institutional innovations at each level of the agricultural system have played an important role in transforming industries (e.g., input, processing, marketing) to allow better coordination between

the different stages and foster productivity growth in the agricultural system. Table 2.1 highlights the changes that take place in different components (techniques, environment, and coordination) of the seed industry as it shifts from stage 1, which is predominantly based on informal seed exchange and characterized by low seed productivity, slow variety development, and a low adoption rate for improved varieties, to higher technology frontiers. In its maturity, the seed industry is characterized by continually increasing seed productivity, a high and predictable rate of

variety development, and rapid adoption of new varieties by farmers. These developments result from the increasing specialization of R&D, public and private production and marketing activities, a well-established legal, proprietary and regulatory framework, pricing policies, efficient public and private extension systems, and the availability of other complementary inputs. Stage 4 is the most conducive for investments in biotechnology research.

Except for selected commodities such as hy-

brid maize, the development of seed industries in Africa is still in a preliminary phase. More than 80 percent of seeds in Africa are supplied by the informal sector (i.e., seeds retained, exchanged, borrowed, or purchased from other farmers). Recognizing the importance of the informal seed sector, and improving the integration of formal and informal seed supply systems so that many more farmers can replace their seed stock regularly with new and improved seeds, will be an essential step in shifting Africa's seed technology frontier outward.

Shifts in farm production technology frontiers are driven by changes in the value of land and labor resources and by higher returns to farming that arise

The current level of adoption of techniques in Africa does not approach the gains realized elsewhere with Green Revolution technology, hybrid seeds and biotechnology. The current low use of improved seed, fertilizer (10 kg/ha on average in Africa, compared with 65-216 kg/ha in Latin America and Asia), and irrigation (4-6 percent of cropped areas in Africa, compared with 40 percent in India and 60 percent in Indonesia), suggests that much of African agriculture is operating at traditional or semi-traditional technology levels.

Table 2.1. Technology Frontiers at Different Stages of the Seed Industry

	Stage 1	Stage 2	Stage 3	Stage 4
	Farmer Selection and Supply	Introduction of Improved Public Varieties	Widespread Use of Improved Public Varieties and Early Spread of Private Varieties	Mature Seed Industry
TECHNIQUES				
Seed R&D	Mass selection; farmers experiment	Public crop breeding research; testing of foreign varieties	Generic seeds; both public and private firms produce new varieties and hybrids	Propriety seeds; private sector produces most new varieties with public research input; public sector does basic R&D for all crops, continues to produce new varieties for self-pollinated and minor crops
Seed Production	By farmers; no distinction between seed production and crop production	Breeders' seed produced by public R&D organizations; basic/foundation seed by government farms or farmers; and commercial seed by government farms, contract growers or farmers	Shared roles for public and private R&D organizations in breeders' seed; increasing activity by private firms in basic and commercial seed production	Breeders', basic, and commercial seed produced by private firms; self-pollinated and minor crop seed produced by farmer cooperatives
ENVIRONMENT				
Marketing and Distribution	Local trading of farmers' seed; uncertainty about seed quality	Distribution by Public and private firms, and farmers; pervasive uncertainty about seed supply and demand	Public and private firms, with the share of private firms increasing; highly risky demand and finance conditions	Private companies; farmer cooperatives
Institutions	Informal habits, custom	Political system begins to enforce property ownership rights	Political system formulations, begins to enforce breeders' rights, commercial contract law, trade secrets laws, quality control regulations, and quarantine laws	Political system capable of enforcing intellectual property rights, plant patent law, and trademarks
Seed prices	Not applicable	Close to grain prices	Seeds have higher prices than grain	Seeds have high prices
Signaling	farmer-to-farmer reputation	Government seed certification label	Certification label and private brand names; seed company reputation	Strong proprietary product differentiation with strong reputation effects
COORDINATION				
Information about new varieties	Other farmers	Public extension service	Other farmers; extension; private advertising	Extension Provides consumer information; advertising
Availability of complementary inputs	Some fertilizer and irrigation	Fertilizers available in limited	Fertilizers and other agricultural	Fertilizers

from improved techniques, market infrastructure, and higher farm gate prices compared with purchased inputs and consumer goods. As the technology frontier shifts outward, more activities related to input production and output marketing are undertaken off the farm, and farm-level production becomes only one of many steps in a vertically coordinated agricultural system.

The parameters of the debate on whether the technology gap in Africa is due to the lack of suitable techniques or a lack of adoption because of environmental constraints are clearly drawn at the farm-level production stage. The implications for research and development strategy are very different. If the principal problem is considered a technical gap, the challenge for agricultural research is to develop techniques that are cost-competitive within the prevailing environment. This may result in techniques that marginally increase productivity rather than lead to quantum-leap improvements, e.g., the introduction of tree crops in areas dominated by shifting cultivation or the development of improved varieties of existing crops.

An alternative view, which underlies the concept of transformation presented in this paper, is that the technology gap results from both the lack of techniques and low levels of adoption. This view implies a research and implementation strategy of investing in the development of techniques and simultaneously improving environmental components (e.g., infrastructure, policies) that will make it cost-effective for farmers and others to use more advanced techniques. Ensuring the development and timely availability of agricultural inputs (especially improved seeds and fertilizers), and creating stable, accessible markets for outputs are important keys to increasing the adoption of techniques and shifting the technology frontier outward in Africa.

The agricultural output marketing system is the primary mechanism for coordinating and guiding production, assembly, processing, storage, distribution, and consumption activities in the commodity chain. In sub-Saharan Africa, traditional marketing systems still prevail for most subsistence and semi-subsistence agricultural products. However, food marketing systems in the industrialized countries and many developing countries of East Asia and Latin America

have undergone dramatic changes in the last three decades. In these developed systems the adoption of new techniques combined with institutional, and organizational changes, have increased the productivity of labor in food marketing and decreased costs. The four broad stages of transformation of the food marketing system are:

1. a traditional system, with little marketable surplus and dominated by the informal sector;
2. a semi-traditional marketing system;
3. an emerging commercial marketing system; and
4. a mature marketing technology which is the frontier marketing technology, with specialized services and well-established institutions guiding and coordinating increasing supplies of fresh and processed food.

The key components of frontier technology in the mature marketing system include:

- *new techniques in packaging, processing, transport, storage, and information processing, which permit the development of supermarket chains that are closely integrated both horizontally and vertically;*
- a system that is programmed back from a well-researched consumer market through wholesale/retail distribution companies, storage, transport, assembly, and finally to the producer;
- more refined government policies concerning marketing, credit and prices, in response to the higher capital intensity of the marketing enterprises;
- widespread contract growing; and
- an increased scale of operation at all levels of the food marketing system.

Shifting the technology frontiers in marketing will require the active participation of African governments in building physical as well as institutional infrastructure (e.g., improvement of farm-to-market roads, market information systems, enforcement of grades and standards), technical assistance programs (e.g., applied research and extension services) and special credit programs to facilitate adoption of new techniques and ease access to working capital.

LESSONS FROM THE CASE STUDIES

The agricultural transformation process is examined through three commodity-focused case studies: 1) maize in southern Africa (Howard, Rubey, and Crawford 1997); 2) poultry production and marketing systems in Asia, Latin America and Africa (Farrelly 1996); and 3) oil palm in Malaysia and Nigeria (Kajisa, Maredia, and Boughton 1997). These case studies illustrate the importance of the agricultural transformation paradigm — namely, techniques, environment, and coordination.

MAJOR LESSONS LEARNED

- *Importance of Technical Innovations.* Breakthroughs in techniques played a significant role in shifting the technology frontiers in all the commodities and countries examined. Technical innovations were not limited to farm-level production but played an important role in all stages of the agricultural system.
- *Complementarity in Improving Techniques, Environment, and Coordination.* The realization of potential productivity gains from technical innovations was made possible or greatly accelerated by simultaneous improvements in system-wide environment and coordination factors.
- *Sustainability of Technological Change and Agricultural Transformation.* The buildup of sufficient human, institutional, and organizational capacity to sustain the system is a key prerequisite for agricultural transformation. Failure to strengthen this capacity may in time reverse the process of agricultural transformation, resulting in an increased technology gap.
- *Different Strategies to Access Techniques.* The case studies illustrate the possibility of pursuing different strategies to access new techniques. These include joint ventures with international companies, importing and testing techniques developed elsewhere, and developing new techniques. In some cases importing new techniques

from the international market in the short-term, with a long-term goal of adaptation, proved to be an effective transfer mechanism because of institutional constraints.

- *Proactive Public and Private Sectors.* The case studies highlight a variety of roles played by the public and private sectors and their potentially synergistic relationship in advancing the technological frontier. In cases where the private sector has taken the initiative in research and development, the public sector played a complementary role by providing an enabling technology environment. As a commodity sector transforms, the public sector's ability to change its role in response to the evolving structure of the sector is critical.

Agricultural enterprises are also subject to enormous risks and uncertainty arising from natural forces. Both technical and institutional innovations are important in minimizing these risks. The development of stress-resistant maize, irrigation systems, disease-resistant chickens, vaccinations, improved hatcheries and housing facilities, are examples of technical innovations that reduced risks and uncertainty and increased productivity. Commodity insurance programs are one example of an institutional innovation that reduces the risk of weather related crop failure for farmers and lending agencies.

Meeting the challenge of increasing agricultural productivity and fostering agricultural transformation requires advancements in all three dimensions of the technology frontier — techniques, technology environment, and coordination.

IMPLICATIONS FOR SUB-SAHARAN AFRICAN NARSS

Meeting the challenge of increasing agricultural productivity and fostering agricultural transformation requires advancements in all three dimensions of the technology frontier — techniques, technology environment, and coordination.

Conventionally, the national agricultural research systems (NARSs) in sub-Saharan Africa have focused almost exclusively on one of these dimensions — technical innovation and governments have concentrated on providing an enabling technology environment and food-system coordination. However, the lack of coordination between these three dimensions of the technology frontier has led to unsustainable technological advancements in many African countries. Moreover, in this “division of labor” between the NARSs and the government, the role of the private sector has generally been neglected.

Closing the technology gap and shifting the technology frontier further in Africa will require concerted efforts by the NARSs, the private sector, and the government. Governments can help facilitate the transformation process by:

- providing effective linkages between investment planning and policy formulation at ministry and inter-ministerial levels;
- promoting collaboration between the public and private sectors; and
- encouraging investment by agricultural system participants other than farmers.

The NARSs in turn can help this integration effort by:

- providing a better understanding of the complementarity between policy, technology, and public and private sector investments;
- identifying constraints and opportunities for realizing productivity gains at the farm level and other stages of the agricultural system; and
- setting research priorities based on the goal of making technologies available (by either creating new technology, adapting technology developed elsewhere, importing or purchasing it from others) designed to promote a path of agricultural system transformation.

There are several research and resource allocation implications for the NARSs to effectively perform this role in promoting agricultural transformation.

Broadening the Scope of NARSs

One underlying theme of the paradigm developed in this paper and illustrated in the case studies is that agricultural transformation involves a system-wide transformation. A systems approach permits greater recognition of opportunities for realizing system-wide productivity gains. The research emphasis of the NARSs should therefore reach beyond farm-level productivity gains to encompass other stages of the agricultural system.

Broadening the Composition of NARSs’ Research Teams

As we move away from subsistence production, the techniques (nonphysical) by environment interactions become significant (e.g., technique by institution, technique by marketing systems interactions), and the importance of using social science tools to manage these interaction increases. Advances in knowledge in the social sciences and in related professions such as law, administration, planning, and social services can reduce the cost of institutional change in the same way that advances in the natural sciences reduce the cost of technical change. To achieve this, NARSs in Africa should strengthen their own social science research programs and foster improved linkages with universities, planning departments, donors, and NGOs to access social science capacity in these organizations.

Shifting the Technology Frontier of the R&D Sector

Like other commodity sectors in the economy, the R&D sector itself goes through different phases of transformation. Shifting the technology frontier further in the commodity sectors requires, first, shifting the R&D sector to the frontier technology. This involves advancing the technology for the discovery of techniques. Scientific instruments, for example, are part of this technology. Well-developed experimental design structures are another. Models of genetic improvement on which animal and plant improvement programs rely are also part of this technology, as are laboratory and experiment station facilities and libraries. The most important parts of R&D technology are people, the organizational structure, research fund-

ing structure, research priority setting mechanisms and linkages with other organizations. Therefore, shifting the technology frontier of the R&D sector requires human resource development, a sustainable funding system, favorable organizational structure, institutionalized planning and priority setting procedures, and research networks that will facilitate advancements in basic scientific research.

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Theme I: Enabling Environment
Topic: Enabling Environment for Agricultural Technology Transfer and Commercialization

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Creating an Enabling Environment for Agricultural Technology Transfer and Commercialization: A Comparative African Study by William A. Amponsah, International Trade Center, Department of Agricultural Education, North Carolina A&T State University, North Carolina, USA

INTRODUCTION

Standard economic growth theory suggests that low income countries should register a faster economic growth than high income countries, because they can borrow technologies from the rest of the world to increase the marginal productivity of capital more rapidly than high income countries. A critical challenge for these countries is to create the enabling environment which would make it possible for them to actively take advantage of the technology, knowledge, and experience of other nations. Nevertheless, available evidence to date suggests that, in Africa, the commitment to open economic development has not been very strong. Therefore, *prima facie* case can be made that the enabling environment has not been effectively created to allow for adoption of appropriate technology in support of managing and sustaining agricultural production and marketing.

CREATING AN ENABLING ENVIRONMENT

Brenner (1993) states that the gap between the frontier of available technology and implemented agricultural production technology is a reflection of the economic environment. It is argued, for example, that the implementation of technology depends on the pattern of incentives deriving from the underlying economic

conditions with which producers are faced in making technology choices. Changes in market incentives affect inter-sectoral resource allocation and, therefore, the level of quasi-fixed inputs in agriculture, which also affect the choice of techniques used.

Reforms of institutions and the development of investment and infrastructure can also enhance the enabling environment for agricultural technology transfer. We argue that ongoing structural adjustment policies in Africa must have a pervasive impact on reforming institutions, creating market incentives, developing infrastructure, and inducing greater investment in support of agricultural technology transfer. These characterize the milieu under which this paper discusses whether the enabling environment exists to facilitate technology transfer and commercialization in sub-Saharan Africa.

Following a general discussion of macroeconomic and agricultural sector performances in SSA, the paper presents a basic framework for creating the enabling environment for agricultural technology transfer in Africa. The comparative lessons gleaned from opportunities and constraints for creating the enabling environment to enhance technology transfer in Ghana and Tanzania are further delineated. These political economy lessons provide the basis for suggesting that the effective enabling environment in support of agricultural technology transfer and commercialization has not occurred in SSA.

MACROECONOMIC POLICY FUNDAMENTALS FOR CREATING AN ENABLING ENVIRONMENT

Research on the determinants of long-term growth reveals that good policies typically translate into faster economic growth (Barro, 1991; Easterly, 1992; Killick, 1992). This is evidenced by other relatively successful developing countries, typically found in Southeast Asia, which have maintained good macroeconomic policies (measured by low inflation, prudent fiscal positions, and realistic exchange rates) so as to turn their economies around.

The impacts of fiscal policies on agriculture are indirectly determined by the linkage between investment and output. For example, growth in agricultural output can come from two sources: increased resources and increased productivity. Typically, increased productivity is influenced by sector-specific and economy-wide pricing policies as well as fiscal policies that influence market incentives. Coupled with sector-specific price and non-price policies, fiscal policies have a direct and an indirect influence on the rate of technical progress through their effects on the rates of return on investments in new technology. For example, using the ratio of government consumption-to-GDP as an indicator of good fiscal policy, the World Bank estimates that, over the typical range of government expenditures, each ten percentage point increase in the ratio of government consumption-to-GDP typically reduces GDP per capita growth by 1.2 percentage points. By 1980, for example, consumption-to-GDP ratios in SSA had reached 17 percentage points, which means that GDP per capita growth in SSA is being reduced at a faster (2.04) rate.

A FRAMEWORK FOR AGRICULTURAL TECHNOLOGY TRANSFER IN SUB- SAHARAN AFRICA

The forces behind the growth in demand for agricultural technology include interactions among the following sets of processes which define a uniform frame-

work for the transfer of agricultural technology in Africa:

- policies that influence the potential of agricultural technology input use through the development of resources which influence upwards the technology response function characterized as market incentives;
- policies that influence the effective demand for the technology by producing knowledge on its use (information flows and education), credit and assured markets for outputs characterized as institutions;
- policies that determine the growth in the supply of technology domestically or the transfer and commercialization through trade characterized as investment; and
- policies that help geographically dispersed technology to be distributed and also determine how they operate characterized as infrastructure.

Therefore, we surmise that the four major elements that should provide the enabling environment in influencing technology adoption, transfer, and commercialization in African countries are market *incentives*, *institutions*, *investment*, and *infrastructure* (the four I's). The key catalysts for the successful functioning of the listed framework are interactions among appropriate micro and macroeconomic policies and a well functioning system of governance. Leadership is critical in encouraging the consultation and participation of all stakeholders in the process of satisfying the four I's. In Africa, these seem to provide the fundamental requisites for creating an enabling environment for technology transfer.

COMPARATIVE CASES OF GHANA AND TANZANIA

Ghana and Tanzania have undertaken macroeconomic adjustments since the mid 1980s. Both nations have experienced a three percent real GDP growth between 1980 and 1990, although Ghana may be viewed as a front runner in advancing economic reforms

since 1983. In 1986, Tanzania began its economic recovery program, which culminated in the first structural adjustment facility in 1987.

Ghana and Tanzania were beneficiaries during the early 1990s of the Sasakawa Global (SG) 2000 program sponsored jointly by the Sasakawa Foundation and the Carter Center. The major objective of the project was to introduce modern agriculture to cereal growers through the use of fertilizers, improved maize varieties, and improved agronomic practices. This objective was predicated on the assumptions that sufficient proven technology existed (patterned after the lessons of the Green Revolution); that it could be used by small farmers; and that it would be profitable in improving their productivity and their incomes. Maize was selected as the primary commodity because it remains, perhaps, sub-Saharan Africa's most important food crop for providing food security. The project, although privately led, was closely integrated with the Ministries of Agriculture of both countries. Regional and district officers of the Ministries performed the key roles of identifying regions and villages (mainly by accessibility and potential to benefit from the project) for the project. Practical and classroom training of extension staff and particular village extension workers formed the key basis for strengthening the linkages among research, extension, credit lending for the small farmer and input distribution. The two case studies illustrate the extent to which structural adjustment policies have created the enabling environment for making improved seed and fertilizers available to small-scale, semi-commercial farmers. Although the project provided incentives in the form of knowledge, germplasm and other inputs, and financial capital in the form of credit to producers, it was weakened by poor policy impacts on institutions, incentives, infrastructure, and investments in particular.

GHANA

The SG 2000 program in Ghana was started in 1984, following the inception of economic reforms with a central objective to increase the production of basic food crops. The new maize varieties promoted under

the program were the *Okomasa* and *Abeleehi* varieties. Two unique activities defined the core programs: technology transfer; and credit and input supply. Therefore, the commercialization of maize was not a key component of the project.

The crop production technology transfer activities were woven around a demonstration extension test plot (ETP). The ETP demonstrated the efficacy in the use of new technology to convince farmers to adopt it. It employed a "learning by doing" approach, allowing the farmer to weigh the risks, costs, and benefits of adopting the new technology. The credit component of the program revolved around the Farmers' Production Plot (FPP) Program. This was a pilot effort to link small farmers directly to local credit institutions. As such, it was a collaborative effort among the Agricultural Extension Services Department (AESD), the Agricultural Development Bank (ADB), and SG 2000. This tripartite alliance encouraged the development of small farmers' groups in the same village, to reduce bank transaction costs for individual small loans, and to exploit the existing "village morality" regarding loan payment, assuring good credit ratings for farmers (in lieu of collateral) and providing credit in the form of inputs (no cash), with the expectation that other members would pay for members in default.

In addition, a post-harvest technology transfer, aimed at reducing farm level post-harvest losses, was started. This program was managed by the Post-Harvest Development Unit (PHDU) of the Crops Services Department. The technology involved dehussing, constructing raised beds and drying patios, sorting, treating with insecticides, and shelling. The program also included training in post-harvest technology. However, no processing activities were undertaken, thus limiting integration with commercial ventures in agribusiness.

Ghana's national seed enterprise, led by the Ghana Seed Company (GSC), was established in the late 1970s. Upon the inception of structural adjustment in 1986, the government privatized the commercial production and distribution segments of the seed industry, leading to the closure of GSC in 1989. SG 2000's role in this program was to assist in the development

of a “seed system” capable of providing a regular supply of superior germplasm of high physical quality to Ghanaian farmers. The 1989 Government of Ghana’s (GOG) Medium Term Agriculture Development Plan assigned a high priority to the development of a private seed industry by using an integrated public/private sector seed production and marketing plan. The concept of a “seed chain” linked the public and private sector groups through the varietal development (breeder’s seed), production (foundation and commercially certified seed), and seed production/marketing and distribution/purchasing and planting. Short one week courses were provided to upgrade the technical skills of seed inspectors and seed production specialists who provided extension assistance to the farmers.

Maize yields of the improved varieties exceeded four tons per hectare, compared to the Ministry of Agriculture’s estimate of 1.4 tons per hectare on, the average, nationwide. This translated into about a 276 percent increase in yields from the new technology. Despite limited data, SG 2000 staff were confident in the maize packages being promoted. Comparisons made from field observations confirmed that ETP grain was more superior to adjacent fields where the technology had not been applied (fields planted haphazardly to local maize seed varieties, with poor weed control, and having fertility problems).

Credit recovery showed some progress following the inception of the program. But by 1989, lower rates of credit recovery were experienced. Credit recovery failed from 80 percent in 1986-1988 to 59 percent in 1992. The poorest loan recovery rates were observed in the Western, Volta, Central, Greater Accra, and Eastern regions, all in the south of Ghana. While the total credit issued was higher under the ETP, the total credit recovery for the FPP program was higher (at 70 percent) than for the ETP program. Although credit recovery problems are mainly blamed on poor management, the following reasons were documented: higher input costs as input subsidies have been removed; high interest charges of 30 percent or more, while farmers were required to make full restitution of loans; recovery payment to be made in cash; and reduced material incentives accruing to participating extension staff.

Taxonomy of Policy Changes

Table 2.2 provides a taxonomy of policy changes and the attendant lessons in Ghana and Tanzania. International experience demonstrates that sustained economic growth is associated with high rates of private savings and investment, extensive links with world markets to facilitate the flow of capital and technology, and a stable environment in terms of exchange and interest rates. Macroeconomic adjustment in Ghana resulted in various policy reforms that should have created the enabling environment for agricultural technology transfer and commercialization. But not all of them had the desired impact.

Some policies were geared toward providing market incentives. For example, the introduction of a market-based exchange rate minimized the possibility of exchange distortions which otherwise could have posed problems for importers of agricultural inputs. Exchange rate overvaluation was corrected, and a foreign retail auction was introduced in September 1986 (excluding petroleum, cocoa, and essential imports). The rate of inflation was brought down from an average of 66 percent in the 1970s to an average of 26 percent during the period of adjustment. By 1991, inflation had been reduced to single-digit levels, although the rate has continued to fluctuate lately. Price controls have been removed, allowing relative prices to adjust under inflation. Also, subsidies for fertilizers and chemicals are being phased out, while marketing and distribution controls are being slowly liberalized. Interest rates have also been liberalized to induce savings and investment. Although the savings rate has improved from about 5 percent to 8 percent of GDP (equivalent to the 1960s level), it is below the average of 13 percent for SSA and 28 percent in Asia.

Analysis of the policy actions revealed that fiscal policy reforms did mobilize resources toward economic resuscitation. The top marginal tax rate on personal income was cut successively from 60 percent in 1985 to 30 percent in 1991, to put more money in the hands of the public, and professional staff were recruited to manage tax revenues. Prudent management of external debt lowered the burden on debt service and led to the accumulation of exchange re-

Table 2.2 Taxonomy of Macroeconomic Policy Changes and Lessons Learned from Ghana and Tanzania

Policy Change	Lessons Learned	
	Ghana	Tanzania
<i>Incentives Policies</i>		
1. Exchange realignment	Reduced exchange distortions, inflation, and monetary base	Exchange appreciation, inflation still high
2. Removal of price controls	Relative price adjustment toward exportables	Gradual elimination except for sugar, petroleum, and fertilizers
3. Subsidies on inputs	Removed subsidies, high price of inputs and low products price	Removed subsidies, high price of inputs and low products price
<i>Investment Policies</i>		
4. Reforms in investment codes	Low private sector investment. Distrust in government.	Very low private sector investment
5. Financial sector reforms	Limited resources to make credit, poor loan recovery	Relatively greater private credits, but not for inputs
6. Liberalization of interest rates	Marginal increase in savings rate (from 5% to 8% of GDP)	Interest rates still negative
<i>Institutional Policies</i>		
7. Fiscal policy reforms	Resource mobilization, low but enlarged tax base, high government spending	High taxes on beer and cigarettes, budget shift toward agriculture, general cutbacks in government spending to reduce deficits
8. Trade liberalization	Phase out of quantitative restrictions, yet poor trade performance in general	Increased share of export earnings allowed to be held by private traders, open general license scheme introduced
9. Duty free facility	Imports of industrial machinery and equipment for processing	Slow imports due to domination by parastatals
10. Reforms in employment	Retrenchment and low wage and other job incentives	Retrenchment, low wages and other incentives
11. Agricultural sector reforms	Dominant role of parastatals in production and marketing, barriers to entry of private agribusiness	Slow reforms agenda, dominant role of parastatals in production and marketing

serves liquidity. After aid-funded imports are excluded, the sustainable level of trade (a measure of openness) is 35 percent of the GDP; substantially lower than most high growth economies. A duty free facility has been made available to support imports of machinery and equipment for, among other things, agricultural processing and industrial investments, while tax rebates are provided on export sales. Government farm estates, fertilizer processing plants, and chemical companies are gradually being divested and liquidated. Quantitative restrictions and foreign exchange controls have been phased out, and taxes on trade have been reduced progressively so as to rationalize the incentive systems and expand trade. Although a value-added tax was introduced in 1995, strong public sentiments against its usefulness caused it to be abrogated. Additionally, the GOG's employment practices kept wages artificially high, and supply response has been limited, especially in agricultural growth which remains sluggish, at pace well below the rest of the economy.

Agricultural sector reforms did seek to reduce the role of public enterprises in the production, pricing, and distribution of agricultural inputs and outputs. To date, marketing structures are underdeveloped and predominantly owned by the public sector, which imposes constraints on attracting private sector investment. The direct impact of government ownership of land and commercial structures on private investment is not clear, although it appears to discourage such an investment. For similar reasons, it appears that private farmers have little incentive to upgrade and develop prime land which is under government ownership. Many legal and institutional barriers exist to restrict the entry of private business in commercial agriculture. For example, in cocoa trading, the Cocoa Board enjoys a monopoly as the sole exporter of cocoa and issues trading permits for domestic traders.

There has not been a coherent policy in support of infrastructural development. During the height of the Ghanaian economic adjustment, foreign aid was used for the importation of capital goods for sectoral (including agricultural) rehabilitation (especially to offset terms of trade losses) and to facilitate policy change. By the late 1980s, for example, Ghana's

foreign aid receipt was ten percent of GDP. Aid allowed the GOG to significantly raise the expenditure on social services and the rehabilitation of infrastructure. To date, however, rural infrastructure continues to be slowly upgraded in support of storage, transportation, and distribution of agricultural inputs and commodities. However, rural feeder roads and critical links with external markets are inadequate. Farmers and rural workers benefited indirectly from improved commodity prices; in part because of relatively high input costs, farmers have not realized positive real prices for cereals.

Other limiting issues that pose challenges for the development and commercialization of technology include poor post-harvest storage and protection against insect and pest infestation, the lack of assured markets for both inputs and products and the lack of access to export and import finance for private firms. The pervasive control of the market by public sector enterprises also places various restrictions on direct foreign and private investments, especially those restrictions on private firms' joint venture activities with foreign firms. Lately, however, the GOG has relaxed some of the controls with the passage of the Free Zone Act 504.

TANZANIA

Initiated in 1989, after the inception of structural adjustment, the SG 2000 program in Tanzania was designed to provide improved seed, fertilizer and crop protection packages to small farmers. In addition to extension advice on the use of modern inputs to increase food production, the primary emphasis was cultivating improved varieties of maize, sorghum, and wheat (Lele, 1992). While modern inputs formed the central strategy of SG 2000 in Tanzania as in Ghana, the major constraints which impeded agricultural sector growth since the 1970s were lack of policies in support of market incentives, institutional reforms, investment growth and infrastructural development.

The SG 2000 program provided seasonal credit and modern inputs to farmers who were registered

with the program. It trained village level extension agents to establish sizable (usually about one acre) management training plots (MTPs) and to collect repayments of loans. Two alternative models were adopted which differed from the Ghanaian approach: to encourage the formation of farmer groups for ordering inputs on a cash basis; and to facilitate the movement of private traders into input trade where a clear input demand was established through the program. The SG 2000 program also emphasized high quality technical assistance and efficient management. Just as in the Ghanaian program, the Tanzanian project worked in collaboration with the existing governmental structure. Although the previous Government of Tanzania (GOT) and World Bank sponsored National Maize Program (NMP) introduced maize farmers to the use of improved seed and subsidized chemical fertilizers, the NMP had failed because of structural impediments and lack of proper management. After nearly 20 years since NMP was introduced and after scores of other donor funded rural development projects, that had virtually the same objectives as the NMP were initiated, only 10 percent of the area planted to maize was under improved seed in 1989, compared to 95 percent in Zimbabwe and 65 percent in Kenya (Lele et al., 1989). According to Lele (1992), it is possible that the area covered by improved maize had fallen even further by 1992, since stocks had accumulated, because of problems in the pricing and distribution of improved maize seed faced by the Tanzania Seed Company (Tanseed). Additionally, in the absence of a national seed policy, improved seed was supplied by a private firm, the Pioneer Seed Company, and imported seed from Kenya and Malawi. Tanzania remains one of the lowest users of fertilizers in the world at eight to nine kilograms per hectare, below Africa's average ten kilograms per hectare. While many reasons account for the low and unstable availability of modern inputs, the most important reason was the GOT relied mainly on ad hoc donations of fertilizers by donors. Therefore, no consistent long-term strategy emerged in the commercialization of fertilizer and other inputs on the Tanzanian market.

If adequate modern inputs were available to farmers, it is believed that Tanzania could increase its food production and, indeed, be more than self-suffi-

cient in food production and export food to its neighbors. The areas of greatest concentration in maize production are in closer proximity to neighboring countries than they are to Dar Es Salaam, the capital city of Tanzania. Therefore, assuming that trade would be done in hard cash, Tanzania could export maize to its neighbors and import to meet the need of Dar Es Salaam (World Bank Tanzania Economic Report, 1991). However, as Lele (1992) observed, to keep the internal prices of maize low, the GOT imposed a ban on maize export. Therefore, the commercialization of maize technology was weakened.

Taxonomy of Policy Changes

The GOT instituted policies to offer greater market incentives. The official exchange rate was depreciated by over 75 percent in real effective terms from 1987 to 1992, which reduced the exchange premium to 20 percent at the beginning of 1993. Tanzanians were allowed to hold foreign currency accounts, and an open general license and foreign bureaus were opened to facilitate moving toward a market-based system in the allocation of foreign exchange. Price controls were gradually eliminated on all products with the exception of sugar, petroleum, and fertilizer. Subsidies on the latter two were being phased out, and almost all goods for sale in the domestic market were decontrolled. However, the GOT's exchange rate adjustment, while a highly desirable reform, increased prices of all imported inputs, including fertilizers and internal transportation, while leaving the export crop prices to producers unchanged. In fact, inflation is still unacceptably high. It seems that parastatals absorbed all gains from adjustments by reducing the producer's share of the final prices below the pre-reform ratio. If the large Tanzanian trade deficit continues, it will dampen exchange returns.

Policies were also designed to boost savings and investment. New private banks were encouraged to begin operation, with increased managerial autonomy and the right to set their own interest rates. Although financial sector reforms began in 1991, preliminary indications are that they are making better banking decisions, are under less pressure to lend, and are expressing the commitment to make more credit available to the private sector. It is expected that the

Tanzanian savings rate will receive a boost when public confidence in the banking system improves. Although the GOT increased its interest rates, the effect was positive. Therefore, the extent to which savings would respond to interest rates alone is not clear. Moreover, increase in interest rates also raised in tandem the cost of working capital relative to returns to private traders. However, the most important constraint the private sector faces is the lack of access to credit. Available data from Coopers and Lybrand indicate that of the top 50 borrowers of the national bank in 1988, 97 percent of the value share of credits were held by parastatals, while three percent were held by the private sector. Credit ceilings which were raised to control inflation also gave rise to a severe credit crunch to private actors, since credit has been allocated almost exclusively to parastatals and cooperatives. Additionally, the consequent financial losses of cooperative unions, as commercial banks were restructured, imposed major fiscal losses on the central bank, which could not collect the funds it had advanced for agriculture.

Institutional reforms have begun in Tanzania. After more than ten years of deliberations, an action plan for the reform of parastatals has emerged. As a result of the economic adjustment, the overall progress in improving fiscal policy has been good. Policy has been good despite the distortion in the composition of the government's budget met by foreign aid. For example, central government finances improved from a deficit of four percent of GDP in 1988 to a surplus of 1.5 percent in 1992. The Reform program, however, is still too new to evaluate.

Comparative Lessons Learned

After almost a decade of structural adjustment, the following stylized generalizations about policy impacts in Ghana and Tanzania (typical of most sub-Saharan African countries) can be delineated from the case examples:

Liberalization has not been taken far enough to markedly increase incentives and, hence, incomes. Public sector actors still dominate in production and marketing (including trade). Macroeconomic reforms, particularly exchange rate devaluation, have removed price controls, but they have also led to the increase

in prices of all imported inputs and internal transportation, and have not resulted in increased crop prices to producers.

Monetary policies have exacerbated inflation but have had marginal impacts on improving interest rates, thus limiting investment and access to technology. Financial sector reforms have sought to improve resource allocation and mobilization. However, it is not clear the extent to which savings are able to respond to pervasive real negative interest rates. Moreover, there is limited access to credit. Credit ceilings have been necessary to control inflation, yet they have caused a severe credit crunch to private sector actors, including farmers.

- The case studies seem to suggest that reforms in agriculture has not been successful enough to enable the transfer and adoption of agricultural technology. Public sector actors have clearly dominated the markets. Additionally, agricultural research and other institutions have been underfunded as a result of fiscal and budgetary crises coming in the wake of the curtailing of governments' expenditures.
- Donors have placed considerable emphasis on improving market intelligence, but while it is important, it is of less value without product mobility, implying that there are still weak transportation and other infrastructure. Donor assistance has been used to support bloated government budgets. However, recent indications from donor countries seem to suggest that faced with domestic budget cuts, aid in support of agricultural research, biotechnology, extension, and marketing are being reduced.

CONCLUDING REMARKS AND RECOMMENDATIONS

Ghana and Tanzania do not seem to have successfully created the market-driven, enabling environment to greatly enhance the transfer and commercialization of agricultural technology. However, they reveal (as in most African countries undertaking reforms) that some of the policy ingredients have been put in place

to bring about potentially sustainable market *incentives, investment, institutions* and *infrastructure*. Indeed, governments need to exhibit greater coordination and commitment in harnessing the economic gains in ensuring a “hassle free” business climate for private sector participation.

Following the onset of macroeconomic structural adjustment, African governments must involve the private sector more in the transfer and commercialization of agricultural technology. Government leadership can be usefully exercised in articulating a set of national objectives which are expected to influence directly or indirectly technology transfer and commercialization. Five principal strategies are recommended. With the assistance of the donor community, government agencies should:

- strengthen the infrastructure and help coordinate the production and distribution of publicly controlled commercial agricultural inputs, commercial seed and fertilizer suppliers as a last resort;
- encourage and provide greater incentives for select resource farmers and firms to grow and sell improved seed varieties through technical assistance on the use of appropriate technology and quality control;
- encourage large companies, both locally and foreign owned, to invest in the technology transfer and commercialization;
- provide public institutional support for training, information networks, credits, and research and development (R&D) know-how in support of private R&D (in this case, the government should enforce regulations that govern intellectual property rights); and
- negotiate for lower tariffs so as to open markets which will help lower input costs for users, including processing industries which may want to produce higher valued (nontraditional) agricultural products for both domestic and foreign markets, to achieve agricultural trade competitiveness.

African governments must encourage institutions to undertake data-based, socioeconomic research sur-

veys of farm households in each African country, by soliciting the impacts of key policy issues on gaining access to agricultural technology and assessing resources at farmers’ and agribusiness’ disposal to adopt and commercialize new technologies. It is advised that nationals of African countries be involved in the conduct and analysis of these surveys. Working with national and regional agricultural research centers and academic institutions, all stakeholders can assist in the implementation of the policy and institutional responses arising from such studies. With the assistance of the donor nations, African governments should increase budgets for universities to undertake training of nationals, to further support the implementation of policies. It is crucial that agricultural policy-makers be capable of monitoring and assessing the impacts of policies. The SG 2000 projects in Ghana and Tanzania have demonstrated that the success of every project would be contingent on the quality of trained personnel who could help the farmers with implementing and managing the programs in the field. Finally, technology influx into a nation, as a result of more open trade, is expected to encourage product diversification. Recent trends in sub-Saharan Africa actually point to the need to diversify from traditional sources of cash crops into non-traditional exports.

Nevertheless, there is cause for optimism in the future. First, during the period of structural adjustment, price distortions are being eliminated, and market incentives are being enhanced to render technological innovation in Africa less risky and more profitable. Second, based on a better policy environment, investments in technology and infrastructure are expected to bring down food production costs. Third, public sector institutional monopolies for agricultural technology supplies are being eliminated, and foreign exchange restrictions on technology imports are being loosened. Fourth, there are renewed efforts to strengthen agricultural research and extension throughout the adjusting countries. Finally, higher-valued (non-traditional) agricultural commodities, such as fruits and vegetables, are replacing traditional roots and tubers in African farming systems. The overarching challenge, however, is how to include appropriate technology transfer policies in any food-based growth strategy.

The critical political economy challenges for sub-Saharan African countries are how to determine which stakeholders beyond parastatals should take over the market commercialization responsibilities. A corollary issue is the timing and sequencing of reform policies during the medium to long-term horizons necessary to successfully execute all the previously delineated action plans. In addition to renewing efforts to successfully create the enabling environment for the commercialization of agricultural technology, African governments must cultivate the systematic culture of inducing private sector entrepreneurship capacity-building among its citizenry.

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Economic Liberalization in Developing Economies: Implications for Support Programs and Fair Competition by John W. Wagonda-Muguli, Permanent Secretary, Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), Uganda

Mr. Chairman, I wish to thank you very much for giving me this opportunity to talk to this August house about economic liberalization in developing economies, implications for support programs, and fair competition. I wish also to thank the previous speaker because he has laid the stage for me in giving all the academic principles involved in the subject matter we are discussing. I look at my presentation as simply supplementing his in that I'm giving the practical experiences in some countries, in particular Uganda, where as a citizen and also as a servant of the government, I have had the privilege to see developments come and go. I may not have the mandate to speak on behalf of other developing countries, but I'm sure there are commonalities that we can go by and where each one of us can see whether we fit within that framework and choose to accept or reject that framework purely on the basis of what is taking place in our own countries. If we cannot agree, at least there will be room for us to recognize our differences.

Mr. Chairman, allow me to say that one of the commonalities of the developing countries are that, at one time or the other, we have all had a colonial experience; that part of the struggle of ending that colonial experience was a direct benefit of the rivalry that was created by the cold war; and that immediately after our attainment of independence, there was a need to experiment with mixed economies. At that time, as a part of what was perceived as a deliberate effort to correct the ills of colonialism, state participation was seen as the order of the day. It will be recalled that it was fashionable for governments at that time to make certain pronouncements. Famous among these is the Arusha declaration of Tanzania, when Dr. Julius Nyerere was announcing takeovers of

certain enterprises by government. Being a close neighbor to Uganda, Dr. Milton Obote, then President of Uganda, made equivocal pronouncements where government acquired fifty-one percent of shares in all major enterprises.

Why am I laboring to give all this background? I'm giving this background because apparently the legacy of the colonial situation is still being blamed even 30-40 years after independence by a number of African governments. Apart from the economic ills that we have gone through, we have also had our share of civil unrest and upheavals, and this has not in anyway assisted the performance of our economies. We have inevitably, therefore, had to look at bilateral funding agencies as a source of funding in order to give a boost to our economies.

As one analyst has said, "the economies of third world countries are all sick and they are only kept alive on artificial respirator of foreign aid."

Ladies and gentleman, this is a serious observation. So take it away, and you'll perish. It is in this context that we should look at liberalization as being a direct product of that situation, in that liberalization has been a conditionality of the structural adjustment programs. You have to accept the structural adjustment programs, because you have to borrow that money to artificially keep your economy running. So what, in real terms, are we talking about when we talk of liberalizing?

In countries that are developed, they talk of the re-emergence of the private sector. But what about in some of our countries, when you talk of a re-emergence of a private sector? Had there been a private sector before that went on retreat? The answer is no. On the contrary, we have never had a viable private

sector. In Uganda, our experience is that, when it came to divesting public enterprises, it soon dawned on us that there was no viable private sector to acquire these private enterprises. What has resulted has been the coming in of foreign investors to acquire those private enterprises. Of course, some of you are aware that in such cases where the acquisition is predominately foreign, with time it is bound to generate local resentment. We have attempted in Uganda to embrace the structural adjustment program requirements through the liberalization of marketing. We have virtually dissolved the marketing boards, or have commercialized them to compete with the private sector. Price controls have been lifted, foreign earnings by exporters can now be retained by those exporters, and the subsidies on imports have been removed. In the same way, credit has also been liberalized, in that interest rates are now set by the banks based on the market. It should be noted that economic liberalization in Uganda cannot be said to be home grown; it has been mainly due to the World Bank's and the International Monetary Fund's structural adjustment programs.

The implications for the farmers are far reaching. Prices of inputs have inevitably gone up, because the government was subsidizing this through its distribution machinery. In the same way, credit used to be delivered through the Ministry of Agriculture, but the government has now moved away from the delivery of credit, and it has to be accessed through commercial banks. Commercial banks, as you are aware, shun away from financing small enterprises, which is characteristic of many agricultural undertakings, not because they are simply small but because they are also risky, and the banks do not want to fully shoulder that credit risk. We have also privatized our state farms. We have tried to commercialize them, and today state farms either make their way, pay their way, or face closure.

Through selective divestiture and selective commercialization, things have improved. It is interesting to know that by the year 1986/87, our production in the agricultural sector had gone to 0.1 percent, but this has been turned around to record a new growth of 6.1 percent in 1994-1995. Now of course when you

hear the dramatic changes in the economy of Uganda, sometimes they are sensational, but you have to understand where we have come from and where we are in order to have the full appreciation of the situation.

How shall we perform in the light of the Uruguay Round II, come the year 2001 or 2002? How do you expect a small farmer producing cane sugar in Uganda, which is a land locked country, to compete fairly with the big sugar producer in the European Union? I think these are questions that we should not simply gloss over, because ultimately they will have a far reaching implication for our economies.

Of course, the World Bank has commended Uganda and Ghana, among other countries, as having performed very well. But what has been the net effect on the small produce farmer? It is interesting that this is not only the situation for Uganda alone, otherwise how come the number of countries referred to as the least developing countries has increased from the original number of 31 to over 42, within the 1980s. I think that gives an impression that the general situation of third world or developing countries is getting worse. Now, how are we likely to perform? Liberalization is linked with globalization of our economies, and globalization gives an added burden for the developing countries to produce as efficiently, if not more efficiently, as the advanced economies.

How shall we perform in the light of the Uruguay Round II, come the year 2001 or 2002? How do you expect a small farmer producing cane sugar in Uganda, which is a land locked country, to compete fairly with the big sugar producer in the European Union? I think these are questions that we should not simply gloss over, because ultimately they will have a far reaching implication for our economies.

Now, Mr. Chairman, we have tried all this, but still we find that we have constraints. Liberalization of markets or liberalization of trade alone are not enough. There has to be a package which should also

see agriculture as a fully commercialized undertaking. It is on that basis that the government of Uganda has now made the commercialization of agriculture a top priority. Unless the farmer in the village can appreciate the importance of commercialization, unless that farmer can target producing for the market, then he will not be able to appreciate investing in agriculture; investing in new technologies to improve production; or cost recovery for state extension services. But once the entire operation is commercialized, the farmer will be able to invest like any other investor would do. Sale of public businesses to the private sector has in a way helped the government to reduce the pressure on budgets to finance public enterprises that otherwise were not making profits. But on the other hand, it has also led to unemployment. Enterprises have had to be restructured, even the public service itself had to be downsized, with serious consequences to the families who are retrenched.

As much as liberalization and privatization are necessary injections, will the private sector be able to shoulder the costs of social adjustment? Have the conditions that led to the emergence of this public sector actually disappeared, or have they simply receded?

Mr. Chairman, we have to ask ourselves the questions:

As much as liberalization and privatization are necessary injections, will the private sector be able to shoulder the costs of social adjustment? Have the conditions that led to the emergence of this public sector actually disappeared, or have they simply receded?

These are far reaching questions which I'd like to invite my colleagues to contemplate. We have a duty to be able to plan for this continent in ensuring that it is fed. Food production in itself has been a daunting

challenge to the African continent. Indeed, the mode of survival has been primarily food aid rather than food production.

When all is said, one thing remains clear, and that is governments have to continue rendering regulatory and facilitating services to ensure fair domestic competition. However, structural adjustment, as part of globalization of the economy, poses new challenges of how to produce competitively with the industrialized countries, in line with the Uruguay Round II and the position of the World Trade Organization.

We need to access the most modern technologies that are available on the market in order to enable us to make a turnaround. That will require very important decisions at the very top level of our governments. But let's not forget that many of our governments experience fiscal deficits. Let's not forget that many of our state enterprises have led to the over expansion of the public sector. Let us also not forget that because of the nature of our economies, we produce what we don't use and use what we don't produce, and we buy at very high costs. Then inevitably there is volatility of inflation and exchange rates, and this poses threats to returns of investment. Let's also not forget that, even in a liberalized environment, there are residual functions that the state has to do, like the provision of infrastructure, the control mechanism, the assurance of quality and standards, and all those things that can give investors an environment that is conducive for investment. If such facilities are coupled with legal instruments that grant reappropriation of capital and a security of investment even in times of turmoil, then we shall have gone a long way in giving the assurance that the foreign investors require.

Finally Mr. Chairman, I would like to say that in many countries, including Uganda initially, preference was given to the foreign investor at the cost of the local investor. We have realized that in order for the economy to tick, the same privileges or incentives for investors should be extended to both local and foreign investors.

Sustainable Financial Institutions for Rural Development by Roland V. Pearson, Executive Director, Ebony Development Alternatives (Pty. Ltd.), Johannesburg, South Africa

Abstract

Finance for agricultural purposes should be seen in the broader context of rural finance. By taking into account activities which are either linked to or completely separate from agriculture, rural financial systems can realize greater potential in depth and breadth of outreach, while lowering the cost and improving the sustainability of providing financial services.

Savings are perhaps more important in varying rural environments than is the provision of credit. Rural inhabitants are often more likely to prefer savings over credit because of the constant and sometimes unpredictable ebbs and flows of economic fortunes, which are tied to weather and other exogenous factors.

Many field and desk studies over the past ten years or more have highlighted several vital lessons in respect to providing rural and agricultural finance in the African context. Some of the most important lessons include:

- restrictive macroeconomic and financial policies tend to raise the cost of providing financial services and reduce outreach, particularly to poorer segments of the population;
- loan targeting, subsidies and usury ceilings reduce the viability of formal and informal financial institutions and thereby limit access to finance for many; and
- low agricultural productivity and poor infrastructure severely retard the development of financial markets.

There are several underlying constraints which have hampered African financial systems. Political interference has been a consistent factor across the continent. Often formal or semiformal financial institutions are state-owned or controlled. While not an inherently negative attribute, direct government involvement has allowed diversion of credit to state-sponsored projects, eroded attention to achieving

sustainability, concentrated service delivery in major cities or politically preferred towns, and undermined prudent management.

Informal systems are often despised and held in suspicion by governments. Tontines, rotating savings and credit associations (ROSCAs), and other community based organizations frequently are viewed as potential political threats and are therefore either squelched or commandeered by governments.

Lack of public funds, national unrest, political favoritism, and other factors have led to a generally poor state of infrastructure in Africa. This deficiency has been most acute in rural areas. Nonexistent communication facilities, lack of access to market information, unsuitable storage facilities, and a myriad of other problems raise the cost of agricultural production and marketing and, in turn, increase the risk and cost of providing financial services to rural areas.

Within this bleak picture are rays of hope. Informal systems exist in spite of, and sometimes instead of, formal systems. However, they tend to be more robust than formal systems.

Informal systems are widespread, albeit largely unconnected, particularly among women. Typically, women make great use of their tontines or savings clubs to start, expand, and diversify their businesses. These systems provide some of the greatest opportunities of support and link with the most disadvantaged populations.

Liberalization and economic reform have begun to be embraced by some African governments. Three positive prospects have arisen from this approach. First, financial sector reform, in particular, has in some cases lifted interest rate ceilings or eliminated quantitative restrictions on credit provision, although not without introduction of new risks. Second, governments may do more than look the other way from informal and semiformal transactions and institutions which currently lie outside of official policy and regu-

lation and rather actively support these systems. Third, more attention on policy and enabling environments has introduced the possibility for innovation at the individual program level.

This situation leads to three key recommendations for improving the delivery of financial services to rural and agricultural areas in Africa.

- Promote linkages between informal and formal systems.
- Integrate finance to agriculture within a broader rural finance context.
- Improve infrastructure, education, marketing policies, and other non-financial elements as prerequisites for effective financial intermediation in rural and agricultural markets.

Availability of and Access to Credit by Small and Medium Scale Farmers for Sustainable Technology Transfer and Commercialization by Pierre Nkepnag, Management Advisor, World Council of Credit Unions, Niamey, Niger

Abstract

Small- and medium-scale farmers in Africa have poor access to credit due to the following reasons.

Small and medium scale farmers are not well organized and/or structured to attract the eyes of the financial institutions.

- They lack the means for organizing themselves. There is too much interference by the states (governments) in the affairs of such farmers, i.e., fixing commodity prices, the stabilization fund system, and high export taxes.
- Although farming is the livelihood for so many small-scale farmers and has been practiced for generations, the farming practices are still primitive.
- Commercial banks are not willing to make credit available to the small-scale farmers due to lack of collateral and self-organization. Banks are unable to evaluate their performance and their loan repayment capability. They are considered as high risk clients with too much burden for too little gain.
- Governments pay only lip service in support of small-scale farmers. They do very little in terms of organizing this sector. The governments take the lion's share of the sale of the produce in the form of taxes and stabilization funds. High input prices as well as fixed prices for the commodities produced are an additional burden to such farmers.
- Agricultural development banks were created in the 1970s as a means of easing the farmers' burden. However, most of them collapsed as they

were established without any feasibility studies based on the farmers' needs. Many farmers lost their hard-earned savings as a result of such failures.

- The situation is now changing due to the economic liberalization and structural adjustment programs being implemented by most African countries since 1990.
- Rural financial institutions are being set up with the help of donor funds, and indications are that donors will do more in this regard.
- These rural financial institutions are generally owned and governed by farmers themselves, are small in size and easily controllable, promote savings and basic management training, and serve as a link between the rural, micro economy and the mainstream macro economy. In order to succeed, they need self-discipline, coordination, cooperation, and complementarity with other well-established financial institutions.
- For rural financial institutions to succeed, it is suggested that promoters should consider long-term sustainability; the beneficiaries should be well-trained in basic financial management, take charge of their own affairs and strive for self-sufficiency. It is further suggested that the African governments should practice true liberalization of the agricultural sector and abolish, or at least reduce, crop export taxes and that donors provide continued assistance to rural financial institutions. The combination of these suggested actions will go a long way in expediting the success of rural financial institutions.

Transportation Technology Links from Farmgate to Distribution Points: The Autocart Story
by H.M. Kamau, Development Engineering Manager, Kenya Vehicle Manufacturers Ltd., Thika,
Kenya

Abstract

Kenya Vehicle Manufacturers Ltd., formerly known as Leyland Kenya Ltd., was Kenya's first vehicle assembly plant, registered on July 2, 1994. Projects currently under development include the assembly of refrigerators and the manufacture of cheap, mass-market, utility, farm-to-market vehicles, the "Autocart." Four prototype vehicles have been built since the project's inception in January 1994 at a total development cost to date of US \$25,000. The three-wheeled Autocart is marketed as a half-ton capacity vehicle with a tare weight of 300 kg and a top speed of 30 km per hour. The vehicle features a hand-pull start, 5.5 horsepower Briggs and Stratton petrol engine driving the single front wheel via a centrifugal clutch. The Autocart is expected to retail at US \$2,500 in Kenya. While there are other roughly similar vehicles in production worldwide, those sold at a similar or lower price range do not have the carrying capacity of the Autocart or its fuel efficiency and its state-of-the-art electronic ignition engine.

The Autocart's best chance of contributing to the revival of Africa's doomed economy is in its utilization in the continent's largest economic sector, agriculture, as a delivery vehicle for smallholder agricultural produce to local markets and as a supply vehicle for agricultural inputs.

The highly perishable nature of horticultural products in particular requires small batch harvests from farms to be delivered immediately to cold storage rooms, a task perfectly suited to the Autocart. If the livestock and fisheries sector is to grow, cheap and sustainable transportation must be provided. The Autocart fulfills this role.

LESSONS LEARNED

- By far the largest proportion of inquiries have been made by smallholder farmers who require a low-speed, half-ton capacity vehicle to deliver their produce directly to markets.
- Another application that proved popular was the use of the Autocart for commercial transportation of water and other commodities. All the customers surveyed only required the vehicle for use in rural and suburban areas and not in major towns.
- Women, who constitute over fifty percent of laborers on rural farms, have expressed interest in purchasing the unit.
- With Africa's average annual per capita income at US \$300, asking US \$2,500 for the Autocart is a tall order, however, smallholder farmers and commercial goods transporters have sufficient cash flow surplus to purchase the vehicle at soft loan rates over a period of three years.
- The use of the informal sector to retail the Autocart would allow for retail and service outlets to be placed on virtually every customer's door step and at very low overhead by using one truck to deliver small batch units to all retail outlets in semi-knocked down (SKD) form for simple assembly on site. The main drawback in using the informal sector for retailing would be their inability to raise short startup capital for a minimum batch quantity of four units in SKD form, at US \$7,500 (\$1,875 per unit). Kenya's vehicle manufacturers (KVMs) will need the assistance of cooperative bodies and donor agencies in providing soft loan financing to retailers.
- A petrol powered engine was selected over a diesel powered unit for its superior power and

torque output for a given engine capacity. The cost and weight of an equally powered diesel unit were too high.

CONSTRAINTS

- The company's attempts to get concessionary duty and value added tax rates for the vehicles on the basis that they were locally designed, developed, and manufactured in Kenya by Kenyans were unsuccessful. The government's lost revenue could be recouped through the increase of income tax paying jobs in the manufacturing sector and general increase in the economic productivity of the agricultural sector.
- Perhaps the biggest drawback in the development of the Autocart has been the total lack of any research, design, and development tools. This has resulted in the production of four prototypes over a three-to-four year development program.
- The unavailability of computer-aided engineering utilizing finite element analysis (FEA) technology is a major factor contributing to the iterative design process which takes too long.
- Due to the rural location of the target customer base and their relative inaccessibility, lack of vehicle maintenance facilities becomes a crucial factor.
- Increased rural job opportunities: The Autocart's rural based retail and service system is intended to provide quality jobs with each retail outlet requiring at least two persons. This effort would contribute to the reduction in rural-urban migration, providing more agricultural workers for increased agricultural output.
- The Autocart is basically a three-wheeled tractor to which its packing crate (rear body) can be attached as a trailer, thereby eliminating packaging waste.
- Another utility feature includes a solar charged battery that can be used to power low capacity electrical devices, e.g., radio, television, etc., in rural areas that have no access to electricity.
- Water pumps, concrete mixers, etc. also can be powered by a belt takeoff drive from the engine. With a water pump attached to the engine and a water tank mounted on the vehicle, the Autocart could also be used to collect water from rivers, dams, streams, and boreholes and deliver it to farmers for irrigation or livestock use.
- SKD assembly of the Autocart at its rural retail outlets would provide for limited rural industrialization and appropriate business for the thousands of engineering and commerce graduates churned out annually by Africa's institutions of higher learning.
- KVMs have provisioned a margin of 25 percent of the recommended sale price of \$2,500 for each business franchise which should allow the franchise owner to cover his costs.

OPPORTUNITIES

- Reduced farming operating costs: A low cost, high capacity transport unit would certainly reduce the small-scale farmers' operation costs.
- The provision of startup subsidies to rural franchise owners by the donor community would help kick start the growth of agricultural business in rural areas and stem the rural-to-urban tide of job seekers.

Theme I: Summary of Discussions

Chair: Moctar Touré, Executive Secretary, SPAAR, World Bank

Rapporteur: Earnestine P. Salmonds, Vice Chancellor for Research,
North Carolina A&T University, USA

Moderators: Charles Whyte, Agribusiness Advisor, USAID/AFR/PSGE/PSD; Jeff Hill,
Technology Transfer Advisor, USAID/AFR/SD/PSGE/TDT

Reporter: Pierre Nkepna, Management Advisor, World Council of Credit Unions, Niger

Creating an enabling environment for technology transfer and commercialization is a continuing process requiring attention to four areas — *incentives, institutions, investments, and infrastructure*. The exact interventions needed will vary from country to country, but can occur through reforms in politics, institutions and infrastructure.

Reforms often require the withdrawal of government from activities that can be more effectively performed by the private sector.

The role of government is to put in place an incentive structure for the enabling environment that includes activities such as establishing policy guidelines, developing legal and financial frameworks, and providing infrastructure support, especially roads and communication systems.

Developing countries will find it difficult to compete with the developed nations as their means of production are not as efficient and advanced as the developed economies. Governments have to continue rendering regulatory and facilitating services to ensure fair domestic competition. The creation of an enabling environment requires leadership, political stability, and careful planning by all stakeholders. Planning is important to mitigate such difficulties as inflationary prices and higher unemployment.

Lack of financial instruments (credit) is often a constraint to technology transfer and commercializa-

tion in rural areas. Lack of mechanisms to enable savings is also a constraint because savings increase the amount of credit available and offer nonagricultural forms of investment to food producers.

Most agricultural development banks which were created as a means of easing the farmers' burden have collapsed, as they were established without any feasibility study based on farmers' needs. Consequently, small- and medium-scale farmers in Africa have poor access to credit. Commercial banks are not willing to make credit available to small-scale farmers due to lack of collateral.

RECOMMENDATIONS

- Governments should consolidate and expand the economic liberalization process and provide institutional, policy, legal, and financial incentives to facilitate the active participation of the private sector in technology transfer and commercialization.
- At all levels, policy dialogue between donors, governments, and potential beneficiaries should address the enabling environment for technology transfer and commercialization.

3. Plenary Session II

Theme II: Generation of Customer Focused Technologies

Topic I: Agricultural Technology Generation and Transfer

Chair: Jacques Ekebil, FAO Representative, Ghana

Rapporteur: Walter Knausenberger, Environmental Advisor, USAID/AFR/SD/PSGE/ENV

Market-Driven, Customer-Focussed Technology Generation: The Need for the 21st Century

by W.S. Alhassan, Director General, Council for Scientific and Industrial Research, Ghana

INTRODUCTION

Ghana, as is well known, is an agricultural country with agriculture contributing about 50 percent of the GDP (contrast 40 percent for Uganda and 25 percent for Kenya). As is the case with most sub-Saharan African countries, about 80 percent of the adult population is engaged in agriculture or an agriculture-related economic activity. Most of our farms are small-scale with average holdings of two ha or less.

The contribution of various commodities to the GDP in Ghana are: roots and tubers, 46 percent; plantain, 9 percent; cocoa, 13 percent; forestry, 11 percent; cereals, 7 percent; livestock, 5 percent; fisheries, 4 percent; fruits and vegetables, 3 percent; and the rest, 2 percent (PPMF 1991). These commodities, except cocoa and timber, contribute to the growing nontraditional export sector. The growth rate in Ghana's agriculture has seen a decline from an estimated 5 percent in the 1979-80 period to the low of 1.2 percent in 1994.

The development of appropriate customer-focussed, sustainable technologies in an enabling environment is urgently required to reverse the decline in Ghana's agriculture. Technology may be simply defined as the application of science to create know-how to generate goods and services for the enhancement of societal well being. Technologies developed must be transferred for commercialization (profit motive or for public good). Technology with a high adoption rate is said to be demand-driven.

This presentation covers the Ghana situation with regard to the various components of technology generation, transfer, and commercialization.

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CURRENT METHODOLOGIES FOR TECHNOLOGY GENERATION AND TRANSFER FOR COMMERCIALIZATION

Technology generation and transfer for commercialization must necessarily identify the types of technologies (production, post-harvest, marketing, etc.) and the target crop. For the purposes of commercialization, the technologies generated must address the entire spectrum from input needs through production to marketing/distribution (processing, packaging,

transport) to the end-users. The technology pipeline involves the various stages of technology generation from concepts to product development to meet client needs. Various pipelines will be considered, and a synthesis proposed.

THE GHANA SYSTEM

The technology generation and transfer for adoption is the responsibility of the Crops Research Institute of the Council for Scientific and Industrial Research of Ghana. The essential steps involve a characterization of the agro-ecosystem including problem diagnosis, design and experimentation, verification of the technology in a target environment, demonstration of the technology, adoption and feedback (monitoring). The feedback from monitoring allows constant updating or readjustment of the technology to fit changing environments.

The Scheme is participatory in as much as it involves researchers, farmers, NGOs, and extension officers. The linkages are established through annual research planning workshops, annual training workshops for research, extension and front-line staff, on-farm trials, joint monitoring tours, production of training and extension materials for distribution, and a national workshop on food and industrial crops. During the planning workshops, various research activities are reviewed and farmers' problems identified and prioritized. The on-farm research team comprises agronomists, economists, and extensionists. There are no animal production experts on the team. Seven teams located in the major agro-ecological zones are used. The on-farm trials are either researcher-managed or farmer-managed. Policymakers join researchers, farmers, and extensionists on monitoring tours.

During the National Workshop on Food and Industrial Crops, research findings are discussed and production recommendation packages presented. Constraints to food and industrial crops are identified and methods to mitigate the constraints discussed.

Technology is developed through crop improvement and management programs covering breeding,

agronomy, protection, post-harvest, and socio-economics. Feedback after years of demonstration of a particular technology enables the assessment of the progress of farmers adopting the recommendations. It has been estimated that 43-48 percent of the total maize area in Ghana was planted to improved varieties (GGDP Annual Reports, 1979-1992). Following these monitoring exercises, a few negative consumer reactions have been reported. For instance, the improved maize varieties are chaffy and do not make good kenkey. The high yielding cassava varieties were the non-mealy types for starch production. For fufu, the mealy types are preferred. Research is in the pipeline to meet the consumer demands.

THE MOROCCAN SYSTEM

This system (Collin and Kissi, 1995) recognizes that research is the engine for agricultural development. The system is in practice at the Institut National de Recherche Agronomique (INRA), Morocco. Just as in the private sector market, research precedes the development of technologies, so in the public sector it is vital to analyze in detail the constraints faced by producers and to identify the technologies they need and will be able to adopt before proceeding to generate the technologies.

Research is to be organized into programs and not on discipline lines. A program is a group of research activities relating to a specific field, e.g.,

- commodity: yam
- group of Commodities: roots and tubers
- agro-ecological zone: savanna zone or desert margins
- production systems: intensive sheep rearing
- production factor: natural resources management

The Moroccan system, like the Ghana System, is intensely participatory and not consultative. The Moroccan system relates to planning before the commencement of technology generation. The steps involved in program planning are:

- Sub-sector Review: National development objectives and the economy are considered. The agroecology and production systems are also reviewed.
- Constraint Analysis: A constraints tree is constructed. In a participatory approach, the central problem is first identified. The cause for this is next defined and, sequentially, the causes of other problems, in a cause and effect relation, are identified. The constraints to increased output may be at the input, production, marketing, storage, processing, or socioeconomic levels.
- Evaluation of Existing Research Results: This is a crucial step to prevent re-inventing the wheel and to plan future researches properly.
- Determination of Research Objectives and Strategy: For each constraint, the research opportunities are identified. A research objectives tree based on the constraints tree can be constructed.
- Identification of Research Projects: The research objectives are grouped into project units such that a research project matches a constraint. Projects can be identified from the objectives tree.
- Priority Setting: Where the number of projects exceed the available resources, prioritization is necessary. The benefit-cost analysis, economic surplus (social gains) concept may be adopted.
- Human Resources Gap: The human resources need is determined and matched against available personnel to determine the gap to be addressed.
- Recommendations for Implementation: This indicates what needs to be done to make the program operational and provides guidelines to policymakers on the measures needed to ensure the adoption of technologies.

Once the program is implemented, it allows for annual and mid-term reviews. The program may stretch for 8-12 years while projects may stretch up to five years.

While the Ghanaian approach outlines key steps in technology development and transfer, the Moroccan approach details the planning process needed to undertake a demand-driven customer focussed study.

CONCLUSION AND GENERAL RECOMMENDATIONS

Demand driven, customer-focussed technologies can only emanate from well thought out programs developed with stakeholders in a participatory approach. The institutional constraints (lack of credit, absence of seed industries, marketing, etc.) must be addressed to create a demand pull for new technologies. The new technologies should enable the upliftment of subsistence production levels into commercialized production levels at the medium to large scale levels of operation in the 21st century.

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The Role of Biotechnology in Generating Commercializable Agricultural Technology by J.A. Brink, Assistant Director, Biotechnology, Agricultural Research Council, Roodeplaat Vegetable and Ornamental Plant Institute, South Africa

Abstract

Biotechnology is the utilization of a biological system to produce a product. A biological system can be plants, animals, and micro organisms. Five key factors required for improvement of crop production are agrochemicals, irrigation, plant breeding, farm management, and plant biotechnology.

Two broad subject disciplines can be identified with respect to plant biotechnology, i.e., plant tissue culture and plant molecular biology. Biotechnology can be classified as enabling technology to assist other disciplines such as plant breeding (e.g., molecular markers) and being incorporated in an end product (e.g., genetic manipulation to obtain a virus resistant plant).

Enabling technology has the following attributes:

- restricted fragment length polymorphism (RFLP) and random amplification of polymorphic DNA (RAPD) analysis to speed up conventional breeding;
- laboratory checks on plant material (genetic fingerprinting);
- diagnostic pathogen detection, enzyme linked amino immuno sorbent assay (ELISA) and polymerase chain reaction (PCR);
- marker assisted selection; and
- screening techniques for stress.

Technology end products include:

- tissue culture dealing with in vitro mass propagation, meristem culture, long-term storage, embryo rescue, anther culture, protoplast fusion, cell suspension cultures;
- somatic embryogenesis; and
- genetic manipulation which involves the inclusion of new genetically engineered sequences into lines and cultivars.

LESSONS LEARNED IN AFRICA

Africa did not benefit much from the “green revolution.” Africa has not yet benefited from plant biotechnology, the so-called “gene revolution.”

- Technology and products commercialized abroad can seldom be utilized directly in Africa due to:
 - different environment and climate;
 - African crops that differ from those abroad;
 - some commercial crops not utilized in Africa; and
 - different needs in developing countries.

African countries do not have a biotechnology policy/strategy in place.

- There isn't much private initiative regarding plant biotechnology in Africa.
- Other countries benefit from Africa's natural resources.
- Many plant biotechnology projects are not demand-driven and do not fit in with national priorities.
- Technology or product transfer to end-users is difficult in Africa due to time constraints, realism, and lack of appropriate channels.

CONSTRAINTS

Constraints include the following:

- Lack of biotechnology resources in Africa including lack of skilled manpower; critical mass; personnel funds and running cost; facilities; mass exodus of skilled manpower from Africa; and

overseas training is not applicable to African situations.

- African crops may be important to Africans, but they are not important enough to attract foreign investment.
- There is a lack of basic crop research in neglected or underutilized African crops.
- Lack of protection of intellectual property rights (IPR) of Africa's own technology as well as technologies developed in other countries.
- Exploitation of Africa's natural resources with no returns to African countries and lack of conservation of Africa's natural resources.
- Lack of linkages, networks, and vested interests, as well as too much competition.
- Commercialized world crops are not so important in Africa, and most of them are not well adapted to Africa; too expensive (premium to be paid); imported lines and cultivars not appropriate; high input requirements; and susceptible to local diseases and insects.
- There is a lack of biotechnology policy/strategy by NARSs including lack of government commitment, public awareness, private initiative, and need-driven projects.
- Lack of biosafety regulations, genetically modified organisms (GMO), patents on genes, processes and technology.

OPPORTUNITIES

Africa can learn from others' mistakes. It can achieve its goal through proper planning, facilitating cooperation among and between countries, and forming networks. There are tremendous opportunities to conserve and develop the natural resources of its wild relatives of commercial crops, neglected and underutilized crops, and plants with pharmaceutical applications (medicinal). The main focus should be on basic crop improvement of neglected crops. Another opportunity is in the area of short, medium, and

long-term training in African universities as well as appropriate universities overseas.

Household food and health security can be ensured through breeding of disease free, higher yielding plants, mass propagation of better quality plants and crops with specific desirable characteristics. Biotechnology can play a role in commercializing crops which can create jobs and earn foreign exchange.

RECOMMENDATIONS

- Formulate national biotechnology policies/strategies for each country.
- Set priorities spelling out who should do what, where, and how.
- Do what can be done with the limited resources available starting with demand driven tissue culture and phasing it in.
- Develop and optimize scientific and human resources by ensuring that available manpower is properly trained and facilities and equipment are adequate. Encourage cooperation between universities, research institutions, the private sector and government agencies, and try to obtain sufficient funding.
- Stimulate private initiative in line with national policy.
- Have biosafety regulations put into place.
- Conserve and develop the natural resources of each country by securing funds for basic crop research, protecting crops from exploitation, and conserving unique germplasm.
- Where possible, utilize technology from developed countries and adapt it to local conditions.
- Ensure that your own intellectual property rights are protected and protect the rights of other countries.
- Stimulate linkages between African countries as well as with the developed world through networks and joint projects.

- Think innovatively, try new ideas and paradigm shifts.

PLANT BIOTECHNOLOGY APPLICATIONS

The following is a summary of possible biotechnology applications.

- improvement of food quality through genetic engineering
- manipulating carotenoids in transgenic plants
- improvement of food quality traits through manipulation of starch biosynthesis
- expression of cholera toxin subunits in plants for use as oral antigens and adjuvants
- bioproduction of human enzymes in transgenic tobacco
- engineering plants for industrial applications including carbohydrates
- reprogramming of oil synthesis in the rapeseed industry
- engineering flower color in horticultural crops
- transgenic plants for durable insect resistance (case study of cotton with *Bacillus thuringiensis*)
- salt tolerance engineering through multiple gene transfers
- improvement of natural disease resistance mechanisms
- biotechnology derived herbicide resistances in crops to meet Third World needs
- designer food-transgenic plants as edible vaccines
- commercial applications of the ethylene biosynthesis of fresh market tomatoes
- development and commercialization of new and improved biopesticides

Topic II: Participatory Technology Generation, Transfer, and Commercialization

Participatory Technology Research and Development: The Experiences of the National Agricultural Research Project (NARP) of Ghana by J.C. Norman, Deputy Director General, CSIR, Ghana

Abstract

The National Agricultural Research Project (NARP) was established in 1992 to revitalize the agricultural research system of Ghana. Farmer participation was an essential element of the anticipated major changes. It had a broad objective to transform the system to ensure that research priorities accord with national objectives and the needs of farmers and other stakeholders in the research system.

PARTICIPATORY RESEARCH AND THE CASE OF THE NARP

Participatory research may be defined as research that involves the participation of farmers and other interested parties in research planning, technology generation, and evaluation of research results. The key characteristics of participatory research may be identified as client-driven, decentralized technology development, devolving to farmers the responsibility of adaptive testing and accountability by all stakeholders for the relevance and quality of technology generated. The NARP identifies the partners in the research process as researchers, extensionists, and farmers. Participatory research, therefore, promotes inter-institutional and multi-disciplinary research approach. NARP decided to undertake participatory research because it has long been recognized that farmers, researchers, and extensionists bring different but complimentary knowledge and experiences to bear when developing technology.

ACTIVITIES OF NARP

The first step in the activities of NARP was the establishment of four special projects (plantain, soybean, pineapple, and rice), selected based on their perceived short-term impacts. The next step was the preparation of the National Agricultural Research Systems Plan (NARSP) to provide a framework for action. In the preparation of the plan, committee members were drawn from the Council of Scientific and Industrial Research (CSIR), universities, the private sector and farmers' associations. All the stakeholders, especially farmers, were adequately represented in the problem identification process. The third step was the setting up of priorities for the various commodities to rationalize resources among competing thrusts. Since this was largely a technical affair, farmers' input into the prioritization process was very minimal.

RESEARCH-EXTENSION-FARMER LINKAGES

In order to facilitate research-extension-farmer linkages, zonal research extension linkages committees (RELCs) have been formed. The RELCs are made up of all stakeholders including farmers. The RELCs are organized at zonal levels with five defined agro-ecological zones in the country. To further improve upon the efficiency and performance of RELCs, a consultative committee has been established whose responsibility includes planning meeting dates at district, regional, and zonal levels. One unique thing about the

NARP is that farmers are involved in the selection of projects to be implemented. Farmers are also invited to field days and workshops.

RELEVANT LESSONS LEARNED

The inception of NARP has led to a situation where farmers and researchers have been able to work together as a group to achieve the common problem of solving farmers' problems.

Since farmers have been part of the research process all along, the technology packages that will emanate from the research system should be readily adopted by them. However, their ability to adopt such technologies will depend on their access to inputs and credit. The fact that there is a constant flow of information between all the stakeholders will help to eliminate suspicion and mistrust among them.

CONSTRAINTS

Even though participatory research is vital to national development, it is costly in terms of manpower, financial resources, and transportation. The untimely release of funds and lack of transportation further compound the problem. Other constraints identified in participatory research include unwillingness of some scientists to work as a team and their reluctance to collaborate with other colleagues. Perhaps one important constraint is the absence of strong farmer organizations to lobby and exert pressure on research organizations and hold them accountable.

OPPORTUNITIES

Through the participatory research approach, research work is now done in a holistic manner covering all agro-ecological zones and all aspects of farmers' problems. The approach develops team work, problems are better identified, and technologies developed are suitable and acceptable to all. Duplication of research efforts is minimized, hence scarce resources are being judiciously used. Scarce intellectual resources scattered all over the country are being tapped for national development. Another opportunity is the interest shown by farmers in research activities. Some have given their plots to researchers for researcher-planned and farmer-managed trials. The continuous dialogue between researchers and farmers helps scientists to gain an insight into farmers' priorities and perceptions.

RECOMMENDATIONS

- Allow farmers' voice to count in the research process; farmer groups should be strengthened.
- The Agricultural Development Bank (ADB) and other commercial banks should be encouraged to make credit facilities available to farmers.
- In order to cut cost and ensure effectiveness, researchers should be limited to specific agro-ecological zones.
- Seminars on new collaborative research should be organized in all major research institutions.
- There is a need to further develop the human resources of the NARSs.
- Monitoring and evaluation need to be further strengthened.

Participatory Research and Development: The Experiences of the Unified Agricultural Extension Program in Uganda by John B. Mubiru, Director of Agricultural Extension, Ministry of Agriculture, Animal Industry and Fisheries, Entebbe, Uganda

INTRODUCTION

Agriculture plays a significant role in Uganda's economy. It accounts for 49 percent of the Gross Domestic Product (GDP), 80 percent of employment, and over 90 percent of commodity exports. It provides raw materials for agro-based industries and markets for manufactured goods (Ministry of Finance and Economic Planning, 1995). It is evident, therefore, that the growth and development in Uganda's agriculture has a direct bearing on the overall economic development of the country.

Agricultural development is a challenge to agricultural research which is mandated to develop technologies that are compatible with farmers' resources, desires, and aspirations. In addition, an agricultural extension system which rationally links researchers, farmers, and policymakers is crucial to ensuring the productivity and sustainability of agricultural endeavors.

In the past, it was assumed that any technology which gave high yields or controlled pests and diseases under research station conditions could be directly and immediately applied by farmers. In other words, technology was supply driven. In many instances this has not been the case. Besides, it has been recognized that many technologies developed by researchers are not necessarily superior to traditional practices at the farm level. This is due, in part, to differences in the availability of resources, the economic viability of the recommendations, and farmers' preferences not considered by researchers (Ugen and Wortmann, 1988). Thus, the need to refocus research efforts in the generation and transfer of technology is clearly evident.

In order to rationalize and harmonize research and delivery of extension services, the Government of Uganda (GOU) organized two Action Planning

Workshops during 1984 and subsequently formulated an agricultural services task force in 1985. Following the task force report in 1987, nine working groups were formed. The findings of the working groups gave birth to the reorganization of agricultural research and extension into the National Agricultural Research Organization (NARO) and the Unified Agricultural Extension Program respectively. The Unified Agricultural Extension Program is implemented by the National Agricultural Extension Service (NAES) in 29 districts of Uganda with support from different projects and donors. The NAES has now been adopted as a national policy and will be introduced in all the 39 districts of Uganda.

ORGANIZATION AND MANAGEMENT

The Unified Agricultural Extension Program is integrated into the regular organizational framework of the Ministry of Agriculture, Animal Industry, and Fisheries (MAAIF). The Permanent Secretary, assisted by the Director of Agricultural Extension (DAE) for crop and animal resources, is responsible for the overall management of the program through policy, technical, procurement, and financial committees. The DAE is responsible for regular management of the extension program by providing advice and guidance to the districts. He is assisted by commissioners, subject matter specialists, zonal extension coordinators, and zonal extension officers from different sub-sectors.

At the district level, the District Extension Coordinator supported by subject matter specialists (SMSs) and, at county level, county extension coordinators, supported by field extension workers (FEWs) placed at sub-county/parish levels (circles) are responsible for managing extension services. However, with decentralization of powers, districts are mandated to plan and manage extension services.

In implementing the unified extension program, the principles of training and visit (T&V) based extension methodology are followed with modifications. A single FEW is responsible for transfer of technology (on crops, livestock, and fisheries) to groups of farmers within a specified geographical area in a manner that encompasses a farming systems approach. It should be noted that the front line extension agents and county level supervisors undertake scheduled visits to designated farmers' groups regularly and are trained systematically by teams of SMSs located at the district headquarters. The SMSs, in turn, are trained regularly through technical workshops by a team of Researchers and by the Ministry Headquarter's senior staff. The training sessions and workshops also provide a forum for feedback. Since the introduction of the unified extension program, greater emphasis has been laid on participatory planning, research, and development where all stakeholders and clients become equal partners in the process.

MECHANISMS FOR PARTICIPATORY RESEARCH

The extension program makes it possible for various stakeholders notably researchers, NGOs, donors, farmers, marketing, and input agencies to interact, thus strengthening linkages between farmers, extension agents, researchers, and marketing agencies. The following mechanisms provide a forum for interaction, joint planning, and implementation of activities among the various stakeholders:

- diagnostic surveys to unearth farmers' constraints;
- pre-seasonal planning workshops for planning research and development strategies;
- technical workshops to review research and especially for transfer of technology;
- monthly training programs for extension workers;
- specialized training programs for extension workers and farmers;
- joint field visits to monitor on-farm research;
- participation in research planning and review meetings;
- adaptive research and on-farm trials;
- joint study tours and field days;
- joint publications among the stakeholders;
- selected demonstrations including whole farm demonstrations on farming;
- system research-extension model; and
- action research and developmental programs.

The above avenues for interaction have enabled farmers and other major actors to get actively involved in technology generation and transfer. Some of the major actors include: NARO; Makerere University (notably, the Faculties of Agriculture and Forestry, and Veterinary Medicine); Management Training and Advisory Center; CARE-Uganda Ltd; Uganda National Farmers' Association; Danish Development Agency (DANIDA) and other aid agencies; NGOs, e.g., ActionAid, USAID, World Vision, and AT-Uganda; and Marketing and credit agencies. The NAES makes it possible for these major stakeholders to initiate and plan pilot interventions (in research & development) together, share the results, and apply successful strategies on a wider scale. Farmers are involved in constraint/problem identification and analysis, on-farm trials, and provide feedback which enables the researchers to refine or change recommendations. The client consultation methodologies, farming system research-extension approach, and bottom-up planning strategy adopted by extension have paved the way for enlisting active participation of clients and other stakeholders in the research and development process. Besides, farmers often have their own traditional agricultural practices which work just as well as those advocated for by researchers and extension workers (Conyers, 1993). This traditional wisdom is used as a basis for fine tuning a number of research recommendations. The following illustrations exemplify how collaboration between farmers, researchers, and extension workers can contribute to generation and transfer of technology.

Grain Storage and Post-Harvest Technology

Some storage structures were introduced from Zimbabwe for testing and adaptation at Kawanda Agricultural Research Institute and at farm levels. Farmers and extension staff actively participated in problem identification and technology generation. The storage structures had concrete bottoms with spouts for taking out the grain. It was found out that this design would not work in Uganda where the moisture level is too high, and farmers generally store unthreshed maize (hence the spout would not work). Two kinds of structures had to be developed: for unthreshed maize where aeration was important; and for threshed maize, and other small grains. The second category consisted of a crib with a cement binder with a bed and a roof. Both were elevated and were provided with rat guards and locking arrangements.

When the designed storage structures were tested at farm levels, many innovations were made by the farmers. Termite resistant materials like palm stems which were available on-farm were used. A mixture of mud and local brew residues were used as binders by many farmers; while others adjusted the height of the structures to suit their convenience and requirements. These modifications made by the farmers have made researchers to fine tune the designs, develop new designs and popularize the same among farmers, resulting in increased rates of acceptance and adoption of the modified structures.

Cassava Agronomy

When cassava mosaic disease struck, there were no resistant varieties to provide to farmers to counter the attack. Instead, extension workers and researchers trained farmers to remove diseased materials from their crop field so that the disease would not spread. Through this collaborative effort, research and extension staff were able to train over 10,000 farmers in this simple technique.

Eventually researchers developed new mosaic resistant varieties. On-farm trials of six different varieties of cassava yielded interesting results. Whereas researchers and extensionists judged a variety based on yield, resistance to pests and drought tolerance, farmers based their preferences on taste and color as

well. The varieties of cassava chosen by the farmers were quite different from the ones chosen by the researchers. The researchers had also recommended a spacing of 1.0 square meter between plants. Instead, farmers chose a spacing of 1.25 square meters to allow for intercropping of cassava with maize and beans. These outstanding experiences of the farmers were later observed jointly in the field by all stakeholders, discussed in technical workshops and fine-tuned the recommendations through on-farm trials for future adoption.

LESSONS, DRAWBACKS, AND OPPORTUNITIES

The interventions promoted through joint participation of all stakeholders and farmers by the Unified Agricultural Extension Service offer a number of lessons and challenges that are worth noting and sharing in the search for accelerating the pace of transfer of technology in developing countries.

Transfer of Low Cost and Appropriate Technologies

The value of transferring appropriate low cost technologies to farmers and sharing their experiences has been amply demonstrated. Such technologies are particularly important for the resource-poor, small-scale farmers to adopt in order to increase their productivity and income. It was further realized that a combination of simple recommendations can produce dramatic results. In banana management, for example, proper spacing, pruning, desuckering, mulching, and cultural methods of pest control, all used in combination, doubled production (Mubiru and Reddy, 1993; Reddy, 1996). A review of the program in 1995 indicated that farmers were successfully motivated to adopt low-cost technologies which resulted in increases of yields from 10 percent to 60 percent, in case of field crops, and from one to four liters of milk per day in case of local cattle (MAAIF, 1995).

Introduction of Degree of Commercialization

The farmers who have adopted low-cost technologies were introduced step by step to a degree of commer-

cialization in farming by adding high-cost inputs. A field extension worker in Tororo District documented the success of one member of a women's group. The lady demonstrated that, given extension advice, access to the necessary production inputs, and determination, farmers can achieve profits of nearly 200 percent in groundnut production. The farmer in question planted two acres with groundnuts in 1994 at a cost of Ushs¹ 272,200. She harvested 38 bags and made a profit of Ushs 487,800. In the first season of 1995, she expanded her production to three acres at a cost of Ushs 490,000. She harvested 66 bags, most of which she sold for Ushs 1,320,000 making a profit of Ushs 830,000.

Group Methods in Transfer of Technology

Group methods such as demonstrations, field days, and group meetings have been found to be cost effective strategies for transfer of technology. In 1995, 75 percent of the farmers who discussed production matters with a FEW reported participating in demonstrations compared to 13 percent who did so in 1992 before the introduction of group methods. Almost 85 percent of the participating farmers adopted the practices on their own fields. In 1992, only 10 percent of interviewed farmers reported awareness of field days. In 1995, 30 percent of the farmers who were aware of extension activities in their area were also aware of a scheduled field day (MAAIF, 1995). Group methods, therefore, enhanced dissemination of information to farmers. Moreover, contributions of farmers to technology generation or modification, as already indicated, can be tapped through group contact and interaction among members. In addition, the agents of change should have a thorough grasp of group dynamics, since, as already noted, the Unified Agricultural Extension Service emphasizes group methods of delivering extension services. Besides, surveys conducted by the MAAIF indicate that farm-

It must be noted that to maintain effective linkages requires a stated commitment and strategy, backed up by resource allocation, to cooperate and collaborate by every stakeholder. Linkages are not cost free.

ers benefit from working in groups and that FEWs have started addressing all aspects of agriculture in their totality.

Regular Contact Between Extension and Farmers

When regular contact between extension agents and researchers, on one hand, and farmers' groups on the other is disrupted, the cohesiveness of the groups suffers. This does not promote a two way communication of ideas. Reduced contact with farmers' groups is often a result of inadequate and irregular flow of operational funds, reductions in the numbers of extension staff through retrenchment, and decentraliza-

tion of powers from central government to local authorities. The implementation of the decentralization policy has, unfortunately, resulted in a weakening of the link between the Ministry headquarters and field staff. Since field staff are now employees of local au-

thorities, they feel detached from the Ministry and therefore not bound to be accountable to MAAIF headquarters. However, arrangements are underway to establish legal links and close working relationships between the field and the Ministry headquarters staff.

Prioritization of Messages and Activities Through Participatory Planning Process

Another important lesson learnt from the implementation of the unified extension approach is that of careful and well considered prioritization of messages and activities. A significant impact was achieved in districts where efforts were directed to a few selected priority enterprises, messages, and/or activities. Evidently this has implications on the selection of technologies to be transferred and on the identification of problems to be researched upon. This is when the concept of participatory planning, which has been nurtured during the implementation of the extension program, can be exploited to reach a consensus. However, consultations that are made with

¹ One US dollar is equivalent to UG shs 1,000.

various stakeholders may result in drawing up a long list of constraints that require attention. The temptation to address many problems at once, therefore, has to be guarded against. The aforesaid calls for extension agents and researchers to have a better understanding of the way farmers prioritize their problems.

Formalization of Research Extension Linkage Mechanisms

In this regard, an initiative has been taken to foster collaboration between researchers and extension staff in Uganda by creating a Research Extension Liaison Unit (RELU) within NARO and posting of extension personnel from the Directorate of Agricultural Extension to research institutes.

It must be noted that to maintain effective linkages requires a stated commitment and strategy, backed up by resource allocation, to cooperate and collaborate by every stakeholder. Linkages are not cost free.

Client Consultation and Participation in Research

The cases presented as an illustration in the previous pages offer an excellent example of how the clients can contribute (joint planning, on-farm trials. etc.) to the process of technology generation and accelerating the adoption process if they are regularly consulted and involved. Furthermore, the outlines presented above indicate that within the framework of the Unified Extension System, an initiative has been taken to institutionalize participatory research and development in Uganda. The positive attitudes of farmers, extension workers, and administrators towards the unified extension approach with the T&V methodology offer an opportunity that can be exploited to revolutionize delivery of extension services, in general, and generation and transfer of technology, in particular.

The challenge to develop technologies that are relevant to and therefore adoptable by commercial, small, medium, and large-scale subsistence farmers will be largely met through the institutionalization and consolidation of the partnership initiatives and client involvement in participatory research and development process mechanisms which are put in place.

However, a number of other issues are yet to be adequately addressed. These include:

- Inadequate funds to undertake joint planning and participation among clients and stakeholders is an issue which requires urgent attention. This needs to be redressed if the program is to meet the challenges of participatory research and development.
- The strategy of rationalization, harmonization, and integration of all the resources of different stakeholders and developing a healthy attitude towards participatory planning, research, and development will help to accelerate the process of

technology generation and transfer. This demands from all stakeholders, among other things, commitment, transparency, and a shared strategic goal.

- More research into the existing organizational structures and institutional management is required in order to refine the technology delivery

system. This will ensure development and provision of technological inputs in a more timely manner and at prices affordable by the farmers.

- Suitable socioeconomic and institutional enabling environments such as access to credit and markets must be put in place. They play a key role in research development, transfer, and adoption of technology. In fact the markets should be able to drive the research and extension.
- The research systems must be aware that a farmer is an economic actor who has to consider costs, benefits, and risks of particular actions. Therefore, if research is to serve development, it should examine farming problems from the farmers' point of view and endeavor to understand his/her motivations, constraints, and strategies.

CONCLUSIONS

Some of the initiatives taken towards participatory research and development within the context of the Unified Agricultural Extension Program in Uganda have been outlined. Although some ground has been covered, a lot is yet to be done if the goal of popular participation in research and development is to be achieved.

The challenge to develop technologies that are relevant to and therefore adoptable by commercial, small, medium, and large-scale subsistence farmers will be largely met through the institutionalization and consolidation of the partnership initiatives and client involvement in participatory research and development process mechanisms which are put in place.

This requires joint planning, monitoring, formal and informal consultations, joint field visits, extensive on-farm research and harmonizing and rationalization of resource allocation, and use among all stakeholders. Besides, involvement of clients in research, adaptation, and development of technology is a crucial factor.

Thus Uganda's model in participatory research and development could be replicated for generating relevant technologies, accelerated pace of adoptions,

increasing household incomes, and improving food security in sub-Saharan Africa.

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Theme II: Summary of Discussions

Chair: Moctar Touré, Executive Secretary, SPAAR, World Bank

Rapporteur: Earnestine P. Salmonds, Vice Chancellor for Research,
North Carolina A&M University, USA

Moderators: Taye Bezaneh, Director of Research, SAFGRAD, Burkina Faso; Abou Thiam, Regional Coordinator, Pesticide Action Network (PAN), Senegal; Walter Knausenberger, Environment Advisor, USAID/AFR/SD/PSGE/ENV; John Durling, Chief Executive, Seed Company of Zimbabwe, Zimbabwe

Reporter: Charles Boaitey, President, Adeemera Enterprise, Inc. Penfield, New York, USA

In agricultural research systems, a customer-focused process is required to ensure appropriate technology development, transfer and commercialization. Customers are end-users (farmers, consumers, input businesses, marketing agents, traders, and processing firms) and transfer agents (extension officers).

Customer focused approaches are also referred to as “demand driven” or “participatory” approaches. Generally, customer-focused approaches involve joint problem definition with end-users, an understanding of the socioeconomic context, integration of relevant disciplines in research and extension, an acceptance of farmers and other customers as experts, and a process of skill building for all persons involved.

For example, Ghana has a system of technology generation and transfer that involves researchers, farmers, agribusinesses, nongovernmental organizations, and extension staff. Difficulties being addressed include the unfamiliarity of scientists with working in teams and the lack of strong farmer organizations to represent farmers interests.

In Uganda, a unified extension system has reduced duplication, improved coordination and developed priorities across programs. Extension, research, and farming are now linked at three levels.

Customer-focused approaches are expensive to maintain, but experience suggests that they are worthwhile in identifying problems and improving productivity. For example, a review of Ghana’s record shows a respectable number of production technologies generated, transferred, and commercialized.

Research systems are oriented to initiating and developing new technologies, but some balance must be found between customer-driven research and research that works creatively to meet a potential demand. For example, biotechnology offers considerable promise but requires national strategies and private initiatives to promote its development.

Research systems are oriented to initiating and developing new technologies, but some balance must be found between customer-driven research and research that works creatively to meet a potential demand. For example, biotechnology offers considerable promise but requires national strategies

and private initiatives to promote its development.

Customer-focused technologies should provide certain advantages. They should offer a high rate of adoption and a high rate of return on investment. They should be cost-effective, efficient, and broadly applicable. They should contribute to a high quality product, enhance people-level impact, and promote partnership among stakeholders.

As research systems respond to customer demand, they will gain better understanding of the mechanisms and processes that promote customer-focused technology.

An additional element in the customer-focused orientation is the element of commercialization and profitability of agriculture, especially for smallholder farmers. There should be an increased focus on the development of appropriate technologies that put money into farmers' pockets on a sustainable basis. Products of such technologies should be market-driven and should involve introduction and promotion of high value crops and trees as well as increased focus on value-added processes that increase the overall value of agriculture. Sustainability should be a key factor in such technologies.

RECOMMENDATIONS

- Research institutions should create mechanisms to respond to customer demand. Experience suggests that research and development should be organized along program lines, not disciplines,

for example by focusing on a group of commodities, an agro-ecological zone, a production system, or a client group.

- Research-development/extension collaboration should be institutionalized in national research and development programs. This could be done, for example, through joint implementation of pilot projects for technology development and transfer.
- In allocating funds for research, governments and donors should target some funds specifically for integrated research requiring inter-institutional and research-development collaboration for particular agro-ecological zones.

Agricultural researchers should conduct market demand analyses, wherever appropriate, to assess the demand for new technologies and identify and address issues of transfer and commercialization during the research process.

4. Plenary Session III

Theme III: Sharing of Technology

Topic I: Intellectual Property Rights

Chair: Sam Muchena, Managing Director, African Fertilizer Development Center, Zimbabwe

Rapporteur: Jeff Hill, Technology Transfer Advisor, USAID/AFR/SD/PSGE/TDT

Advancing Intellectual Property Rights by Naboth Mvere, Attorney, Honey and Blackenberg, Harare, Zimbabwe

Abstract

The main elements of intellectual property rights include patents of invention, trademarks, industrial designs, restriction of unfair competition, trade secrets, copyright, and neighboring rights. This presentation is limited to patents, trademarks, and industrial designs.

Patent of Invention: An invention is a novel idea which permits in practice the solution of a problem in a field of technology. In the agricultural context, its importance will be the protection of new plant varieties although this is usually under a *sui generis* law in most countries. Utility models or “petty patents” protect inventions and innovations with a lower threshold of inventiveness than required for patents and is useful for the protection of small agricultural implements.

To be patentable, an invention should be new, non-obvious, and industrially applicable which includes application in agriculture. The rationale behind the patent system is the *quid pro quo* where the patentee is required to give a full protection and guarantee by the State for him to exploit the invention for a limited time. Full disclosure means that anybody skilled in the art in the particular field of the invention should be able to read the specification and carry out the invention.

Trademarks: These are a sign (word, letters, numbers, label, colors, etc. or a combination thereof) used to distinguish the goods and services of one commercial or industrial enterprise from the other. Trademarks perform four main functions, namely distin-

guishing, source indication, assurance of quality, and advertising.

Industrial Designs: These protect the shape and configuration of an article provided it is new, appeals to the eye, and is industrially applicable.

LESSONS LEARNED

Countries have laws to protect Industrial Property for two main reasons. One is to give statutory expression to the moral and economic rights of creators in their creations and the other is to promote, as a deliberate act of government policy, creativity, and the dissemination and application of its results and to encourage trade. An equitable and modern patent system, by providing recognition and material benefits to the inventor, constitutes an incentive for inventiveness and innovation activity. It creates a favorable climate for the transfer of technology by means of the security it provides for the patentee.

PATENTS AS A SOURCE OF TECHNOLOGICAL INFORMATION

Patents

- provide the most up-to-date information on any field of technology;
- are classified and therefore easily accessible;

- provide technical information for research activities (improvement patent);
- identify alternative technologies available (e.g., for licensing purposes);
- provide state-of-the-art information (avoid reinventing the wheel); and
- keep one abreast of the competition.

CONSTRAINTS

Constraints include the following:

- cost of patenting and enforcing (legal fees);
- lack of public awareness including policymakers, research scientists and law enforcement agents;
- lack of technical capacity to unpackage existing

technology contained in patent document; and

- lack of financing for research and development.

RECOMMENDATIONS

In order to promote intellectual property rights, the following recommended actions are necessary: public awareness programs; technically biased education curricula to inculcate technology culture; identifying and funding of viable inventions for commercialization; involvement of the private sector in research and development; strengthening of national and regional industrial property institutions; updating of national industrial property laws to adequately protect new and emerging technologies; and rendering an adequate protection to the patentee/inventor thus creating an enabling environment.

The African Intellectual Property Organization (AIPO) Experience on Industrial Property Applied to Development in Africa by Makita Mbama Albert, Administrator Delegate, AIPO, Yaounde, Cameroon

Abstract

Before 1960, the date of the independence of most African countries, now Member States of AIPO, Industrial Property was governed by the French National Law. After independence, former French Trust Territories in Africa, instead of adopting an individual Office of Industrial Property, decided to create a common Office which was considered as a national office in each Member State. AIPO was created by the Libreville Agreement on September 13, 1962 which was replaced by a revised agreement, known as the Bangui Agreement of March 2, 1977. AIPO's actions are based on three basic principles: the adoption of one single legislation (the Bangui Agreement); the creation of a common Office seated in Yaounde, Cameroon; and the centralization of procedures, i.e., a single deposit, tax and title. AIPO now regulates Industrial Property in each of the 15 member countries, namely Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Congo, Côte d'Ivoire, Djibouti, Gabon, Guinea, Mali, Mauritania, Niger, Senegal, and Togo.

The organization covers the domains of patents, utility models, trademarks, industrial designs, trade names, unfair competition, appellations of source, copyrights, and patrimony.

CONSTRAINTS

The main difficulty encountered since the organization's creation is the noninvolvement of Industrial Property in the development of Member States which is due to:

- weakness of the industrial section in the economies of the States;
- lack of technological and scientific culture;
- shortage of local structures specialized in arbitrating disputes concerning Industrial Property;

- lack of knowledge about the importance of Industrial Property regarding evaluation of risks; and
- lack of interest by administrators in charge of economic supervision and fraud control to recognize the role of Industrial Property as a means of intervention.

In order to cope with the above constraints, AIPO has adopted/proposed the following solutions: promotion of the handicraft sector; reinforcement of the capacity of the legal system in Member States to resolve disputes related to Industrial Property; promotion of technology and entrepreneurship; intensification of training and sensitizing actions; and valorization of the results of research.

RECOMMENDATIONS

- African countries must establish an efficient system of Intellectual Property in order to make their territories attractive to national and international investors.
- Industrial Property must be recognized and given more importance by the education system at the primary and secondary schools as well as institutions of higher learning.
- National Offices of Industrial Property must carry out intensive training actions in the Industrial Property domain.
- States must carry out sensitizing actions regarding the role of Industrial Property in the development of the national economy.
- African Offices of Industrial Property must create a cooperative network.

***The Legal Framework for Property Protection, Investment, and Technology Transfer:
Challenges for the 21st Century*** by Fred O. Boadu, Professor, Department of Agricultural
Economics, Texas A&M University, College Station, Texas, USA

INTRODUCTION

The major challenges facing agricultural experts and policymakers for the 21st century are to improve food security, check high population growth, and eliminate malnutrition, all within the context of a sustainable environment. Successful collaboration is inextricably tied to the existence of a credible legal framework, good faith, equity, and a vision of the world that transcends national borders.

This paper examines the relationships between the legal framework for property protection, investment, and technology transfer in the context of the transition to a market economy. The paper also discusses the relevance of the domestic and international legal regimes for agricultural technology development, transfer, and use. The argument is made that discrete, isolated changes in the legal regime for intellectual property in SSA may not necessarily lead to an increase in technology transfers from the industrialized countries to the region, nor an increase in domestic private sector investment in technology development. What is needed is a broader agenda to increase credibility in the overall legal regime, especially the regime for enforcing contracts. The lessons learned over time, the constraints and opportunities in technology development and transfer are reviewed. Suggestions for strengthening the legal framework in support of property rights in agricultural technology, investments, and technology transfer are presented in the conclusion.

What is needed is a broader agenda to increase credibility in the overall legal regime, especially the regime for enforcing contracts.

LEGAL FRAMEWORK, PROPERTY RIGHTS, AND MARKETS

The transition to a market economy requires that the legal framework performs, at a minimum, three basic functions (Gray, 1991): 1) to define the universe of property rights in the system; 2) to set the rules for the entry and exit of actors into and out of productive activities; and 3) to set the rules of market exchange.

A legal regime with these characteristics serves to reduce risks and uncertainty facing market participants, reduces information, bargaining, and enforcement costs facing private entities who interact repeatedly in the market through contract institutions. The regime also helps to reduce opportunism and solves the costly

“assurance” problem which usually reduces contracting and interactions in a market. A central institution of a market system is a regime of non-attenuated property rights. Usually property rights are easily understood in the context of the more “traditional connotation of property as a piece of land or a dwelling” (Bromley, 1989). Recently however, the world has come to recognize intellectual property rights (creations of the mind) such as, property rights in a new high-yield seed variety, animals, and plants as property.

Intellectual Property

According to the World Intellectual Property Organization (WIPO), “intellectual property shall include the rights relating to: literary, artistic, and scientific works; performances of performing artists, phonograms, and broadcasts; inventions in all fields of

human endeavor; scientific discoveries; industrial designs; trademarks, service marks, commercial names and designations; protection against unfair competition; and all other rights resulting from intellectual activity in the industrial, scientific, literary, or artistic fields” (Convention Establishing the World Intellectual Property Organization, signed at Stockholm, July 4, 1967, Art 2 (viii)). These items are “intellectual” in the sense that “these kinds of property are distinct from real estate or personal property in that they are the products of the human mind or intellect. Information is a non-rival good, since the use of information does not reduce the amount of the good available to others” (Thompson, 1991). Once information is produced and made available to the public, it becomes nonexcludable unless institutional mechanisms are put in place to protect it. In the case of intellectual property, patents, copyrights, trademarks, trade secrets, and secrecy agreements are used to provide exclusion. In the specific case of biotechnology, patents are used. The owner of the patent is granted the right to prevent others from making, using, or selling his or her invention (Foltz and Penn, 1992).

Intellectual Property Protection for Agricultural Inventions

Protection of agricultural inventions has evolved differently from protection of industrial inventions. Historically, and even today, most national laws explicitly exclude agricultural inventions from their patent laws (Lesser, 1990). Even though the patenting of living organisms has a long history (Straus, 1995), intensive discussion of the legal issues is fairly recent. The first task is to attempt a stylized presentation of the various forms of protection for agricultural inventions.

SEEDS AND PLANTS

The legal tools for protecting seeds and plants differ in domestic and international law and also among countries. Looking at the protection schemes on a continuum, the United States and Japan have the broadest scheme of protection for living organisms.

In these two countries, patents are used to protect seeds and plants. Under U.S. law, there are two distinct forms of patent or patent-like protection.

Plant Patent Act (PPA) of 1930

The Act states: Whoever invents or discovers and asexually reproduces any distinct and new variety of plant, including cultivated crops, mutants, and newly found seedlings, other than a tuber propagated plant or a plant found in an uncultivated state, may obtain a patent subject to the conditions and requirements of this title. The provisions of this title relating to patents for inventions shall apply to patents for plants, except as otherwise provided (35 U.S.C. § 161).

The Plant Variety Protection Act (PVPA) of 1970

The Act states: The breeder of any novel variety of sexually reproduced plant (other than fungi, bacteria, or first generation hybrids) who has so reproduced the variety, or his successor in interest, shall be entitled to plant variety protection (7 U.S.C. § 2402 (a)).

As the court explained in *Chakrabarty*, “sexually reproduced plants were not included under the PPA (1930) because new varieties could not be reproduced true-to-type through seedlings.” By 1970, however, it was generally recognized that true-to-type reproduction was possible and the plant patent protection was therefore appropriate. The 1970 Act extended this protection. Unlike the PPA, where the Patents and Trademarks Office grants patents, the PVPA is administered by the U.S. Department of Agriculture which issues plant variety certificates granting exclusive rights to the owner to exclude others from “selling the variety, or offering it for sale, or reproducing it, or importing, or exporting, or using it in producing (as distinguished from developing) a hybrid or different variety therefrom.” (7 U.S.C. § 2483 (a)). The distinction between producing and developing made by the PVPA leads us to international efforts to protect rights in plants and seeds.

Convention of the International Union for the Protection of New Plant Varieties (UPOV)

UPOV covers plant varieties only and was adopted in 1960. UPOV confers protection in the form of plant

breeders' rights (PBRs). Under UPOV, the new plant variety must be: stable (that it reproduces true to form over repeated propagation); homogeneous (that important characteristics are uniform across a single planting); and clearly distinguishable from existing varieties, but not necessarily in an economic or agroeconomic sense (Lesser, 1990). PBRs are subject to two important exemptions: a farmers' exemption, and a research exemption. The farmers' exemption gives users the right to retain part of the harvest for subsequent replanting as seed, and the research exemption permits breeders to use a protected variety in subsequent breeding and to apply for protection of the outcome as long as repeated use of the protected variety is not required (Lesser, 1990). There is some consensus that the protection offered under the UPOV is inadequate for generic, that is generally applicable biotechnological advances since the PBR relate always to a specific plant variety only (Straus, 1995; Lesser, 1990).

PATENTS FOR NONPLANT LIFE FORMS

The *Chakrabarty* case (see p. XX) opened the debate concerning patents for non-plant life forms. The U.S. Supreme Court held that the existence of the PPA and PVPA did not preclude the grant of utility patents for other life forms such as bacteria and multicellular higher life forms. *Chakrabarty's* invention was recognized under Section 101 of the U.S. Patent Law.

BIOTECHNOLOGY

Biotechnology is "the science of changing the genetic structure of living organisms in the manufacture of drugs or other products or in producing new life forms of living organisms" (McCarthy, 1991). Given the dire need to expand food production in SSA, some considered the advent of biotechnology in the 1970s to be the silver bullet to finally put hunger and malnutrition to sleep. Productivity increases of about

20-40 percent were predicted, but this has not happened (Brauer, 1995). Lesser (1990) has outlined the many difficult issues surrounding the protection of biotechnology products as distinct from other forms of technology:

- Because genetically improved seeds can be replicated naturally, secrecy offers no protection beyond the usual time lags required for copying. Hence, legal protection is often the only available form of protection.
- It can be difficult to identify a patented plant product and define exactly what has been patented because plants and seeds are subject to natural genetic drift and spontaneous mutation.
- Agricultural inventions can give rise to a chain of derivative inventions, with the result that multiple royalties may accrue on a single product. In legal parlance, this is known as "dependence."
- It is virtually impossible for holders of patents on engineered microorganisms to prove infringement.

BIODIVERSITY

More so than national laws, international law is the major mechanism guiding the use of biodiversity resources. The Convention on Biological Diversity (Rio Convention) is the controlling legal regime on biodiversity. Some have argued that the Convention requires "developing countries to receive intellectual property rights in pharmaceutically-useful chemicals derived from their biodiversity resources" (Kadidal, 1993). Article 15 recognizes states' sovereignty over their natural resources, including "the authority to determine access to genetic resources." It also requires signatories to take whatever measures are necessary to ensure that the results and benefits of research utilizing genetic resources are shared fairly with the nation of origin." The Convention, however, "fails to propose a regime to assign the resulting intellectual property rights" (Kadidal, 1993).

IS A STRONGER INTELLECTUAL PROPERTY RIGHTS REGIME NECESSARY IN SSA?

The answer to this question depends on who it addresses. If the question is posed to a technology development firm in a developed country, the response will be an unequivocal “yes.” Countries in SSA, on the other hand, are suspicious of a rigid intellectual property rights regime. Primo-Braga (1990) has used a benefit-cost framework to conveniently summarize the main arguments for and against the institution of stronger intellectual property rights in developing countries including SSA.

COSTS

Administration and Enforcement

A good legal regime must have effective and credible mechanisms for enforcing laws. There are no available estimates on the cost of enforcing Intellectual Property Rights (IPRs) in developing countries, but it is known that these costs are not trivial. Already, the legal regime in most SSA countries is overburdened and costly to use. A decision to have a full-fledged IPR enforcement regime must be based on a careful assessment of the capacity to enforce it.

Increased Royalty Payments

Since most countries in SSA are net importers of technology, the establishment of a stronger IPR regime would increase the level of payments to developed country exporters of technology. Even though the experience of Brazil shows that the effect on the balance of payments of the country may be slight (Primo-Braga, 1990), for some countries in SSA any further burden on the balance of payments could hardly be described as slight.

Displacement of “Pirates”

“Pirate” denotes an economic agent riding free on the intellectual property of another economic agent, irrespective of legality. Since technology is imported into

developing countries, the absence of an effective IPR regime allows domestic firms to “free ride” on the IPR of exporting firms. If countries in SSA adopt strong IPR regimes, they will lose pirate revenues. Note, however, that the argument does not take into account the effect of the absence of an effective IPR regime on the willingness of domestic entrepreneurs to participate in technology development.

Anti-competitive Effects

There are concerns that a strengthened IPR regime could lead to increased prices for technology. Prices may increase due to increased royalty payments and also due to the granting of monopoly power to the technology developer. Note that this is an old argument in the economics literature and represents more the distinction between “static” and “dynamic” efficiency. Those who advocate a free flow of information in order to increase consumer welfare have not adequately addressed the issue of how the information will be produced in the first place. The other concern in this area is “patent nonuse.” This problem can, however, be addressed by procedural rules that accompany the granting of a patent.

BENEFITS

Domestic Research and Development (R&D)

The evidence on the importance of a stronger intellectual property rights regime for research and development in developing countries is mixed. Some have suggested that developing countries are better off spending their limited resources on education in the technical and science fields than on laws to protect inventions. Pointing to the experiences of East Asian countries, the argument has been made that a country can significantly increase its technological capacity before reforming its IPR regime. Others argue that a strong IPR regime could contribute to firms making R&D a more systematic activity with an overall stronger commitment to innovation. Whether the current low level of R&D expenditure on technology development by the private sector in SSA has anything to

do with the absence of a strong IPR regime has not been addressed.

Global Technological Dynamism

The concern here is that the absence of an effective IPR regime may chill the development of domestic research efforts to develop technologies for the international market. The other argument is that foreign firms may not develop those technologies for which developing countries have no adequate protections of IPRs. The empirical evidence in support of these arguments is scant.

Capital Formation

Countries in SSA have made significant efforts to attract foreign investments. The numerous trade missions, trade fairs, workshops, etc. undertaken by countries are all intended to attract foreign investment. According to the Organization for Economic Cooperation and Development (OECD), the absence of IPR regimes is a deterrent to these efforts. Other experts have suggested that the impact of weak IPR systems is overshadowed by the overall economic environment of the country. There is no definitive answer to the issue of how IPRs influence foreign capital investments in SSA.

Technology Transfer

It has been suggested that owners of proprietary technology are unlikely to transfer the knowledge to countries that do not have adequate IPR regimes to protect that knowledge. In evaluating this proposition, one has to consider the fact that licensing has been an effective mechanism for transferring technology to developing countries. Once again, the absence of an overall improvement in the legal regimes of countries may weigh more than the absence of an IPR regime *per se*.

Trade Effect

Developing countries that have significant trade links with developed countries have to worry about potential revenue losses from retaliatory trade actions by developed countries. In the context of SSA, failure on the part of a country to institute an effective IPR regime could mean loss of preferential trade treatment status by developed countries. So far this has not been an issue, but could be so if countries in SSA make significant strides in exports and technology development. What bears watching is the require-

ments of what is known as the Trade-Related Aspects of Intellectual Property Rights (TRIP) under the recently concluded GATT. Under TRIP, all countries within a five- to ten-year period are to provide the following forms of protection:

- Contracting parties shall provide for the protection of plant varieties by patents and/or an effective *situ generous* (meaning separate law like UPOV) system (Section 5, Article 27 [3b]).
- Plants and animals other than microorganisms and “essentially biological processes for the production of plants and animals” may be excluded from protection (Section 5, Article 27 [3b]).

Lesser (1994) has explained that these provisions allow countries to exclude plants and animals from patent protection by choice. In effect, the politically unpopular linkage between trade laws and IPR protection is still the most powerful tool for developed countries to get favorable protection of transferred technology.

WHAT IS THE ROLE OF THE PRIVATE SECTOR?

The pattern of biotechnological development points to an important role for the private sector in developing countries. Unlike the case of the “green revolu-

The private sector, working through the market system, is the source of the “demand pull” which drives the development of new technologies. At present, the main force during the development of biotechnology is the “supply pull.”

tion” where governments played a leading role, biotechnology development has been driven primarily by the private sector (Brauer, 1995). However, in SSA, the public sector and international organizations dominate research activities. It is therefore difficult to obtain reliable answers to the question of what role the private sector ought to play in biotechnology development.

To better appreciate the importance of the private sector, a quick review of funding sources for agricultural research is in order. Government funding of research has suffered declines over time. The Consultative Group on International Agricultural Research Centers (CGIARs) has suffered funding cuts of over 35 percent over the last three years (Lesser, 1994). In terms of government support, there have been across-the-board decline of funds over time. More telling is the low public expenditure on research and development (R&D) activities.

The participation of the private sector could have both direct and indirect employment effects. The direct effect will be on the employment of suppliers (biotechnology companies) and users (agriculture, health, industry). The indirect effects would be felt through investment multipliers, income and demand made possible by the cost reductions as technology improves (OECD, 1989). One may argue that, given the current stage of technology development on the continent, it is premature to address these multiplier effects. Actually, pointing out these potential benefits is one way to encourage aggressive actions to promote the development of biotechnology in the region.

The private sector, working through the market system, is the source of the “demand pull” which drives the development of new technologies. At present, the main force during the development of biotechnology is the “supply pull.”

Research laboratories are developing new products which are being introduced to consumers for possible adoption. The demand pull will add to this force in order to hasten the pace of technology development.

Developed countries are increasingly using indirect mechanisms to secure credible commitments to intellectual property protection in developing countries. For example, the U.S. and the European Community are using trade laws, under the new GATT International Trade Organization (ITO) regime, to enforce intellectual property rights. Under the “Super 301” legislation, the U.S. can restrict the trade of a country that does not abide by proper intellectual property protection.

LESSONS LEARNED

- The lessons learned over the years cover issues in both technology transfer and technology generation, research and institutional support systems, and overall policy initiatives as they apply to crop, forest, and animal resources in SSA. A major problem in summarizing the lessons learned over the years is obviously the rather dispersed initiatives spread over several research centers in SSA and in foreign laboratories. Any summary is therefore a first approximation.
- In the context of SSA, there exists both “wide technology transfer gaps and a serious technology generation gap” (Kassapu and Singh, 1993).
- The application of biotechnology to animal production represents the weakest area of research in SSA. The productivity of African breeds is low, and the use of simpler technologies such as artificial insemination is not developed (Kassapu and Singh, 1993). In the livestock sector, single-gene products such as bovine and porcine somatotropin have been known to increase productivity considerably. The development of new animal vaccines for cattle and poultry are expected to have a major impact in increasing productivity. Also, changes in animal feed formulas are expected to increase productivity.

- The relationship between biotechnology research and natural resources should be understood in the context of how best countries in SSA can best share/protect their rich biodiversity resources. Developing countries are using private contract arrangements involving the major biotechnology research entities in the industrialized countries to control the use of rich plant resources in their forests.
- In general, countries in SSA have not followed the patent approach in protecting seeds and plants. Countries have excluded seeds and plants from intellectual property protection (Lesser, 1990). Countries are not signatories to the UPOV, and have instead adopted the WIPO model patent law which excludes protection for “plant and animal varieties and essentially biological processes for the production of plants and animals” (Lesser, 1990).

Developed countries are increasingly using indirect mechanisms to secure credible commitments to intellectual property protection in developing countries. For example, the U.S. and the European Community are using trade laws, under the new GATT International Trade Organization (ITO) regime, to enforce intellectual property rights. Under the “Super 301” legislation, the U.S. can restrict the trade of a country that does not abide by proper intellectual property protection.

- Countries in SSA have planted the seeds for harmonizing intellectual property protection that meets their special circumstances. The two regional organizations - the African Regional Property Organization (EUROPE), and the Organisation Africaine de la Propriete Intellectuelle (OAPI) are spearheading the harmonization effort. These regional organizations have not yet displaced national legislation
- The general legal regime in countries is backlogged and not conducive to contract enforcement. In Ghana, for example, court statistics show that, for the 10-year period from 1980 to 1989, there were 4,175 cases filed of which on average

4,108 cases were carried over to the following year. Such a heavy backlog in case disposal may be a more powerful signal to technology sellers that the court system is incapable of resolving conflicts. In effect, discrete changes in the legal regime for intellectual property rights may not defeat the negative perception about the effectiveness of the overall legal regime.

- The role of the private sector in the development of agricultural technology and research is almost nonexistent. A significant amount of research is conducted in the International Agricultural Research Centers (IARCs) within the CGIARs. Returns to research conducted in these institutions are very high as shown in Table 3.1.. The question, however, must be posed whether CGIAR research “crowds out” the growth of domestic resident researchers.

THE PROBLEM OF FORUM

The legal regime influencing agricultural technology today consists of domestic legislation, bilateral and international treaties, and regional arrangements. Even though these institutions play different roles, there are often overlaps in their work.

Countries in SSA rely primarily on institutions such as WIPO and the FAO for most of their technical and data needs.

The presence of other forums raises the cost of using the services of these agencies, and in effect the cost of technology transferred to developing countries. A major concern today is the issue of breeders’ rights and farmers’ privileges as originally approved under the UPOV. Originally, breeders could use a protected variety for creating and commercializing a new variety, and farmers were permitted to multiply propagation material of a protected variety to be used for further growing on their own premises. These provisions have been eliminated under the revised UPOV convention of April 1991 (FAO, 1995). In effect, industrialized countries are pushing for universal application of the patent system to living mat-

Table 4.1. Rates of Return in Agricultural Research and Extension Services

Scope of Study	Range of Estimated Returns on Investment (in %)		
	0 - 20	30 - 50	50+
Returns to Public Research			
Developed Countries	3	28	23
Developing Countries	8	28	37
International Research			12
Returns to Private Research**			
Developed Countries			3
Developing Countries		1	1
<i>Source: Evenson, 1989</i> * Studies on CIGAR international research centers ** Research on agricultural machinery and agricultural chemicals			

Table 4.2. Availability of New Technologies for Selected Crops

Crop	New Diagnostics	Rapid Propagation System	Transformation	Regeneration	Time Frame
Banana/Plantain	+	+	-	+	5-10
Cassava	+	+	-	-	5-10
Cocoa	+	-	-	-	>10
Coconut	+	-	-	-	>10
Coffee	+	+	-	+	5-10
Oilpalm	+	+	-	-	>10
Potato	+	+	+	+	<5
Rapeseed	+	+	+	+	<5
Rice	+	+	+	+	<5
Wheat	+	+	-	-	>10
<i>Source: Breaur, 1995</i>					

ter, including plants and animals. The UPOV provisions will, however, erode FAO's efforts at finding a compromise between breeders' rights and farmers' rights as stipulated in the International Undertaking on Plant Genetic Resources of 1989, which was approved by all member nations of the FAO (FAO, 1995).

OPPORTUNITIES AND CHALLENGES

- The primary focus of plant biotechnology research in SSA is the application of tissue culture technologies for the micro propagation and production of disease-free plants. Research has focused also on the development of drought tolerance, pests and disease resistance, and weed control. There are efforts to establish gene banks for the preservation and exchange of germplasm, and also to preserve the rich genetic diversity found in SSA. The international research institutions are at the forefront of this research. There are opportunities for countries in SSA to collaborate in these efforts to build domestic research capabilities.
- As some observers put it, "The prevailing image of biotechnology is now that of an all-pervasive, profit-generating technology playing a strategic role in maintaining and enhancing national competitiveness in an environment of global economic interaction" (Tzotzos and Leopold, 1995). The proposition here is that, properly organized, countries in SSA have an opportunity to not only respond to the dire need to feed the booming population, but also in the process, to effectively tap into a very lucrative international biotechnology market in order to improve the balance of payments, create employment, and attack poverty.
- Table 2 shows the trade impact of micro propagation and recombinant DNA technologies on the trade of export crops of interest to countries in SSA. As table 2 shows, there is a critical need for countries to undertake immediate policy reforms in order to participate in the approximately \$42 billion tissue culture technology market and the estimated \$24 billion genetic engineering market (Brauer, 1995). Opportunities exist for countries in SSA because the commercial interests of the agro-chemical industries in the industrialized countries have shifted to the production of temperate crops. Crops of major importance to countries in SSA (roots, tubers, plantains) and hardwood have not received maximum attention from mainstream research (Brauer, 1995).
- The downside of the trade issue is the accelerated pace at which developed countries are substituting high-value components of specific products originally derived from the produce of developing countries. The effect is to limit the market opportunities for the export of these products from developing countries. For example, the laboratory production of natural vanilla flavor could lead to a loss of over \$50 million in export earnings from Madagascar, and threaten the livelihood of over 70,000 small farmers (FAO, 1995). Also, the substitution of high fructose corn syrup from maize led to a loss of over \$400 million in sugar export revenues from the Philippines, and a job loss of over 500,000. In West Africa, the substitution of cocoa butter with cheaper vegetable oil could have significant adverse export revenue impacts for countries like Ghana who are major exporters of cocoa.

RECOMMENDATIONS

- Countries in SSA must work hard to improve the overall law and regulatory regime in order to build the credibility needed to attract private investment to the region.
- In the immediate term, countries must search for low cost strategies to enforce IPRs. This may be accomplished through better coordination with international organizations directly involved in technology development and transfer.

- The most effective strategy to involve the private sector in agricultural technology development and transfer is to devise a mechanism which makes them pay for the use of the technology. For example, the possibility of a check-off system for financing research must be explored. The goal is to make private entities the “owners” of research developed in the laboratories.
- Efforts should be made to strengthen regional organizations as a way to refocus attention on regional markets. The crops and animals of interest are very local and have not been of interest to developed country research institutions. The challenge is for researchers in SSA to work on those products that have markets in the region.
- We must strengthen the information network in the region.
- In order to strengthen the technology transfer contract regime, countries must seek greater collaboration with the international research centers, especially the CGIARs. Such collaboration will significantly reduce the cost of acquiring technology.
- Strengthening domestic research efforts may mean a change in the mission of the CGIARs. These centers could become transparency agencies, which means a reduction in their research undertaking. Care must be taken so that the CGIARs do not crowd out domestic research.

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Topic II: Information Sharing and Dissemination in Accelerating Agricultural Technology Transfer and Commercialization

Transfer and Commercialization of Food Grain Production Technologies in Semi-arid West and Central Africa: Some Cases and Issues by Taye Bezuneh, International Coordinator, OAU/STRUC-SAFGRAD, Ouagadougou, Burkina Faso; Kimseyinga Savadogo, Maître de Conférences Agrégé, School of Economics, University of Ouagadougou, Burkina Faso; and John H. Sanders, Professor, Agricultural Economics, Purdue University

INTRODUCTION

Sustained technology diffusion will occur when producers perceive the benefits of acquiring technologies. A successful commercialization of technologies by the private sector requires profitability (well functioning input and product markets) and that farmers have the ability of access to the inputs (credit, own generated cash).

The public sector can play a significant role in technology diffusion through the promotion of enabling factors, e.g., research, road infrastructure, regulatory environment and any other incentive that can lead farmers to accept a new technology, or the market to deliver such technology to the users. The role of the public sector can remain essential in case of thin markets, such as the diffusion of technologies for the subsistence crop.

The purpose of this paper is to review the trend of commercialization of some technologies through public, NGOs, and farmers' participation and private channels. The paper first discusses some issues related to technology adoption/diffusion, then moves on to presenting cases of successful and promising technologies. The paper concludes with lessons learned from the SAFGRAD Project as to the types of technologies that are successful, the reasons why they are successful and the respective roles of government and the private sector.

SOME ISSUES ON TECHNOLOGY ADOPTION

Technologies come in different forms, and the problems of the diffusion of a technology depend to some extent on its characteristics. Thus, one-time use technology-embodied inputs such as fertilizers and seeds face different problems compared to investment type technologies such as farm implements and some water retention technologies. Similarly, the chances of success also depend on the crop to which the technology

is applied, commercial vs. subsistence crops. The following is a review of five key factors affecting a sustained technology acceptance

by farmers in the semi-arid tropics of West and Central Africa.

Institutions

There has been poor performance of the public sector in the delivery of agricultural inputs and technological services to spur economic growth in sub-Saharan Africa. Consequently, many countries are going through radical institutional changes to put in place a conducive and enabling environment for the private sector to assume these functions.

Privatization, having its many virtues, is not a panacea for all development activities.

The transitional period from public sector to market-oriented economies in Africa requires political and social stability and investment. Without new

Privatization, having its many virtues, is not a panacea for all development activities.

injection of capital for agricultural development and support to input and credit services, the stewardship for technology development, transfer, and marketing, etc. from public to private sector would take several years.

There is concern that all unplanned privatization of key agricultural institutions may take countries backward rather than advancing the performance of the agricultural sector. A successful institutional buildup to promote the private sector in delivering agricultural technologies and services must go through smooth transition phases, depending on the type of technology or service.

In the short run, some aspects of technologies and services can be passed over to the private sector. These include the marketing of some products, in particular capital goods such as tillage implements, the mechanics and utilization of which require little training or technical knowledge to master. Chemical technology-embodied inputs such as fertilizers, although they can be marketed by private merchants, require technology knowledge on appropriate formula and application. For such inputs, there is a necessity for the public sector to provide information services until the time the private sector can build up its own experience.

In the longer run, many services related to technology commercialization can be privatized, including information services on product utilization. This requires a conscious effort to train the necessary personnel, with regard not only to product knowledge, but also with the necessary institutional safeguards to combat fraudulent behavior (such as allowing the sale of outdated products, products unfit for given crops, etc.). It is the public sector's responsibility to build these control institutions, which will define the legal framework of the functioning of input markets.

Relative Prices and Product Markets

It is well documented that farmers will not use, on a sustained basis, technologies that are not profitable. Profitability depends, *inter alia*, on the output/input price ratio. A ratio significantly greater than two is judged a necessary condition for farmers to continue to use a given input (Dembele, 1996). In general,

technology diffusion has been easier on commercial crops such as cotton, which benefit from a stable and a high enough relative price. Output prices for cotton and maize have been shown to have a strong impact on production in the favorable Southwest region of Burkina Faso (Savadogo et al., 1995), and this finding runs counter to the prevailing pessimism of a low supply response of agriculture to incentives in the Sahel. A different problem, however, lies with the subsistence or less commercialized crops, sorghum and millet, which are characterized by volatile year to year prices. For example, Boughton et al. (cited in Dembele) report that farmers in Mali decreased their use of inorganic fertilizer on maize following the withdrawal of the state from product marketing, which led to unstable prices.

Food crop prices are the result of the interplay of the overall performance of agricultural production and consumers' demand. The latter depends on consumers' preferences and the available alternatives. In the case of the Francophone countries of sub-Saharan Africa, the convertibility of the currency and the overvalued exchange rate before 1994 have favored the importation of food for urban consumption. This meant a diminished effective demand for domestic rural production, and this inelastic demand in turn explained the observed year to year fluctuations of the prices of the main staples including maize, sorghum, and millet. Under these conditions, farmers have been reluctant to invest in cash demanding inputs, such as inorganic fertilizers or seeds, and relied heavily on labor-intensive technologies, such as water retention dikes or "zai" for these crops (Sanders and Vitale, 1996).

The dilemma of stable prices in the semi-arid tropics of West Africa is how to develop a product market able to sustain prices, even in good years. Sanders and Vitale (1996) argue that governments have the responsibility to prevent the large harvest time collapse of crop prices. They note that in developed countries, governments do not allow farm prices to collapse, unless farmers are compensated through income transfers. This is a key issue, yet overlooked by policymakers. Besides direct government intervention to control prices (which has unfortunately

been a failure in most of sub-Saharan Africa), prices can be stabilized at an incentive level through various actions.

One action is to encourage the processing of the traditional cereals. This will eventually increase the demand for these products, in particular in the wake of the 1994 devaluation of the CFA franc and the ensuing rise in imported food price.² Governments have a key role to play in this, for instance in providing incentives such as tax breaks to private companies engaged in food processing.

A second feasible action to stabilize output prices is through the geographic interlinking of markets, both within and between countries. Improving road infrastructure between deficit and surplus areas within a country facilitates the spatial transfer of products, increases effective demand at harvest time, and may dampen the price collapse. Likewise, freeing regional markets and promoting trade between complementary countries, such as the Sahel and the coastal countries of West Africa, may stabilize demand and prices, and increase food security (Savadogo, 1996).

A third action is to encourage the use of surplus product as animal feed. Sanders (1996) documents the rise of sorghum as a feed crop in Honduras, from 4 percent of total concentrate use in 1985, to 25 percent in 1993. This was obtained under conditions of rapidly growing demand for poultry (8.4 percent per year) which translated into a derived demand for sorghum. The devaluation of the CFA franc and the resulting increased demand for local meat products in West Africa may justify the intensification of livestock raising. Using sorghum or maize as a feed supplement is foreseeable in this area.

Input Distribution

Technologies are embodied in inputs. The functioning of input markets in the area of government withdrawal and private sector takeover raises many issues (Dembele, 1996). One is the ability of private mer-

chants to effectively deliver inputs to farmers, at the right time and on a regular basis. If supply becomes uncertain, the use of inputs is likely to become discontinued. This is the case for fertilizers and seeds. The second issue is related to the transaction cost tied to input distribution. Government parastatals such as those operating in the cotton sector are able to pool risk over regions and enforce payment by farmers based on the linking of the input and the output markets. Private merchants are unlikely to eliminate risk related to non-payment, and therefore are likely to restrict input sale through credit, leading to lower demand by farmers. Reducing the transaction costs is essential to improving input availability, but this is not easy for the traditional cereals.

Of particular concern is providing technology for the small-scale farmer in a system of private inputs commercialization. Because of the singularly elevated risk associated with credit in subsistence cropping, and the lack of own-cash in acquiring inputs necessary in the stabilization of an overall declining soil fertility, the small-farm sector poses serious problems for a sustainable agricultural production. There appears to be a need for a special emphasis on fine tuning the input distribution system to address this problem, which concerns most of the farmers and the agricultural land in countries such as Burkina Faso.

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² In Burkina, imports of rice have dropped by 40,000 metric tons in 1996, i.e., nearly by half of pre-devaluation volumes.

Land Tenure Systems

There is reason to believe that land tenure may impact on technology adoption. Property rights are believed to exert a profound effect on incentives, resource allocation and overall economic performance (Feder and Feeny, 1993). The uncertain property rights over land may impede for instance long-term investment type technologies such as tree planting. Likewise, lack of well defined property rights may prevent land from being used as collateral in input acquiring credit schemes. This problem is the consequence of and is compounded by the lack of a market for land in most of the countries under analysis in this paper.

A case study of Thailand (Feder, 1993) concludes that legal land ownership rights positively affect farmers' productivity. The investigation of rainfed agriculture in some African countries (Migot-Adholla, et al., 1993) suggests that the impact of land tenure systems is blurred by too many other structural constraints, including poor rural health and education and low level physical infrastructure and technology. However, as countries progressively overcome these constraints, land tenure becomes a factor that needs to be dealt with.

Information

Information on performing technologies and on product markets is essential for farmers' decision. Allowing information to flow is the responsibility of government, at least until a private entity can take over. However, we are witnessing the progressive withdrawal of government from many services, including extension, the major source of information in present farming conditions. If the acquisition of information becomes costly following privatization, the issues are whether the cost of provision will be supported by the sellers of technologies (merchants) or by farmers. Irrespective of the mode adopted, the price farmers will end up paying for the technologies will probably embody the price of information. It is fair to suggest that information services should be subsidized.

An example of the information gap can be found in the distribution of fertilizers in newly liberalized markets, as in Burkina Faso. Fertilizers come in different formulas and quality, which poses problems

for the non-trained sellers and farmers. This lack of technical knowledge of the chemical characteristics of the product is particularly detrimental to farmers, as they may acquire ineffective products and therefore lose confidence and restrain from further adoption.³

CASES OF SUCCESSFULLY COMMERCIALIZED TECHNOLOGIES

This section illustrates some cases of successful technologies and attempts to show the reasons for their success.

Animal Traction and Inorganic Fertilizer in Cotton Production

The case of cotton illustrates a successful combination of technologies to enhance production, both of cotton and food crops listed in rotation with cotton, maize in Burkina Faso and Mali and sorghum in Northern Cameroon. Although natural factors (good rainfall) were key to reducing the yield risk associated with the use of inorganic fertilizers in these regions, human factors were also essential.

In the case of Burkina Faso, performance indicators include rising yields and social infrastructure build up in the cotton zones. Cotton yield and area planted increased from less than 200 kg/ha and 25,000 ha in the fifties, to above 13 ton/ha and 180,000 ha, respectively, in the mid-eighties. The yield of maize and area planted parallel increased over the same period. Maize yields increased from less than 800 kg/ha in 1965 to over a ton/ha in the early nineties (Sanders et al., 1996).

Food Grain Technologies

Over the last decade, there has been successful introduction and adoption of early maturing maize and cowpea cultivars in semi-arid West and Central Af-

³This is documented by Dembele, Rockefeller Research Fellow, IFDC-Africa, working with the Soil Fertility Management Unit of Burkina Faso, Ouagadougou.

rica. In the Sudano-Guinean zone, maize production along with cotton has substantially increased due to new, early maturing cultivars, improved agronomic practices, animal traction, etc. Short-cycle, improved sorghum and millet cultivars that were successfully introduced have benefited very little from inputs, such as fertilizer and water retention technologies to maximize yield returns. These crops, however, occupy over half of the cropped area in the semi-arid West and Central Africa, where low-soil fertility problems prevail.

The sustained diffusion and adoption of food grain production technologies depend on an adequately functioning seed industry and fertilizer distribution agency.

The existing public parastatal institutions that are involved in the multiplication of seed and distribution of inputs are being phased out. Until viable private or revitalized public institutions are put in place, there is need to strengthen farmer-research linkages in order to encourage and enable the farmer to produce seed of improved cultivars. Farmers cooperatives could also be assisted to eventually assume the distribution of inputs.

The following section of the paper highlights the introduction, adoption and trends of commercialization of maize, cowpea, and sorghum production technologies.

CASE ONE — NEW MAIZE CULTIVARS ARE FILLING THE HUNGER GAPS IN THE SAHEL

The International Maize and Wheat Improvement Center (CIMMYT), the International Institute for Tropical Agriculture (IITA) and SAFGRAD have been supporting the development of new maize cultivars over the last two decades. In the 1980s, with the active support of the cotton parastatals in the various Sahelian countries, there was a rapid introduction of new maize cultivars and increased levels of inorganic fertilizer use. Similar rapid technological changes also occurred in some of the coastal countries, such as

Ghana. In the Sahelian countries, there was policy support not only for the new cultivars and credit for fertilizers, but also a guaranteed price since the parastatals were encouraging alternative industrial uses of maize. When the parastatals decided that these maize policies were too expensive and withdrew their price supports and input subsidies, the use of inputs and expansion of maize production decreased. However, the new technology response is now known and, depending upon product price and profitability, we would expect to see the further expansion of the new maize cultivars and recovery in the use of inorganic fertilizers. Maize appears to be a classic case of using public policy and an input subsidy to begin the diffusion process by helping to subsidize the initial learning cost with a new technology and then ceasing these measures. Farmers reduce fertilizer use but continue to use the new cultivars and some inorganic fertilizers depending upon the evolution of the market. Presently in southern Mali, there has been a substantial increase in the maize price as the region has increased its maize exports to the coastal countries.

...[T]here is need to strengthen farmer-research linkages in order to encourage and enable the farmer to produce seed of improved cultivars.

The SAFGRAD/IITA supported adaptive research program on maize has emphasized earliness (90 days) and extra-earliness (less than 85 days) suitable for the Northern Guinea and Sudanian zones, respectively. For example, in the far north and north province of Cameroon, the availability of short cycle maize cultivars has increased maize production to about 35,000 ha, “filling the food shortage” before the above mentioned staple cereals are harvested. These and other short cycle maize cultivars are appreciated by farmers due to their earliness and for use of green maize within 65 days from planting (SAFGRAD Phase II Report and Sanders et al. Impact Study, 1994).

Similarly in Mali, the cultivation of extra-early varieties occupy about 10 percent of the cultivated

area. These cultivars are highly commercialized around Bamako and other urban centers for “green maize” market with horticultural crops.

Technology Transfer Via NGOs

For farmers in the semi-arid Sahel region, the most trying period is between May and August; by then sorghum and millet, the two principal cereals, have not yet matured and grain stocks are running low. By providing farmers in Burkina Faso and other Sahelian countries with early maturing maize varieties, the SAFGRAD project is seeking to help them overcome this critical “hunger gap.”

In the village of Kokologho, 45 kilometers southwest of Ouagadougou, Burkina Faso’s capital, farmers are now able to raise the new maize varieties to satisfy their families’ needs during the hunger period. Even more, they have grown surpluses they can sell to supplement family incomes.

Through its various trials across West and Central Africa, SAFGRAD tested and refined the maize varieties. The varieties are appreciated for their good taste, favorable yields (3-4 tons per hectare), resistance to common pests and diseases and ability to mature rapidly. Getting the seeds to farmers has been a major obstacle for extensive production. However, seed services are virtually nonfunctional or do not exist in many Sahelian countries, but farmers in remote areas far from seed centers, often do not have access to the varieties. And if they do, the price may be prohibitive.

To overcome this problem, SAFGRAD decided to involve nongovernmental organizations (NGOs). It was Sahel Solidarity, an NGO in Burkina Faso, that actually got the seeds to Kokologho’s farmers with assistance from SAFGRAD, Burkina’s National Agricultural Research Institute and the Sahelian NGO Coordinating Secretariat, which operates on a regional level.

Farmers in Kokologho were taught how to multiply their own seeds. From a single kilogram of maize seed, they produced more than 300 kilograms. Small quantities of the seed were then provided to each family in the village to sow around their houses

at planting time in June. By the end of August, the maize was available. Those farmers who planted even earlier started harvesting the maize while their millet and sorghum were still at the flowering stage.

The benefits were not confined to Kokologho alone. The seed produced by the farmers was more than they needed for their own use, so they provided the surplus to 24 other villages for further multiplication.

Helping farmers to produce their own planting material not only contributes to reducing hunger, but complements the activities of the national seed services. The experience in Kokologho, like similar ones elsewhere in the Sahel, highlights the importance of collaboration among policy makers, national research institutions and NGOs. By working together, they can encourage farmers to utilize proven technologies to solve their specific food problems, while progressively advancing towards the attainment of food self-sufficiency (Menyonga, 1995).

CASE TWO — SORGHUM: TRANSFER AND SHARING OF TECHNOLOGY

There has been increased introduction of improved sorghum cultivars. This crop did not benefit, however, from the application of improved inputs and credit systems. The liquidity constraints and price collapse that farmers encounter are two of the major barriers to the adoption and diffusion of improved cereals technologies.

The S-35, a short cycle (90 days) cultivar was released in northern Cameroon by 1983. The National Cereals Research and Extension Project (NCRE) and SAFGRAD extensively evaluated this cultivar on farmers fields and observed that the yields of S-35 were almost double compared to the local and other improved sorghum cultivars during drought years. Based on the conservative estimate, S-35 is cultivated on 30,000 ha in the drier Sudanian zones of Cameroon. The success with S-35 has been due to its earliness (drought escape) and seed quality, such as the white seeded low tanin grain. One of the drawbacks to this

cultivar is that it is very susceptible to Striga and highly preferred by birds. Except for drought or poor rainfall years, the yield gains from S-35 were minimal. S-35 has transcended the borders of Cameroon to Chad, a good example of “spill over” or sharing of technologies from one country to another, where it was quickly verified and released. Through ICRISAT/FAO technical assistance, S-35 cultivation extended to more than 25,000 ha in Chad.

Industrial utilization of sorghum in Nigeria and other countries in West Africa has increasingly become prominent. In Nigeria, since 1987 there has been a gradual transition from use of barley malt to sorghum grain malt in the production of lager beer and stout. Sorghum is also used in beverages, sugar confectionaries, for production of weaning foods, for malt drinks, biscuits, etc.

The relative importance of these industrial uses of sorghum is still minimal. The rapid introduction of the variety SK-5912 came with the recognition of its favorable characteristics for beer. SK-5912 has been reported grown on about 1,000,000 ha in Nigeria under the contracts for brewing and infant industry. In Cameroon, there is also increasing interest among developers and researchers in meeting the industrial demand of sorghum for both bread and beer.

CASE THREE — COWPEA: MARKET DRIVEN TECHNOLOGY DIFFUSION

Cowpea is an important source of protein improving the nutrition of over 150 million people in West and Central Africa. In the Sudanian and Sahelian zones, there has been successful introduction of the early maturing cowpea cultivars. These new cultivars, having multiple resistance to insects and diseases, were diffused very fast by farmers themselves and through the conventional extension-farmers operational framework. Cowpea is being harvested before sorghum and millet to meet both food and cash shortages during the critical period.

Even though the adoption of more productive technologies of maize, sorghum, cowpea, etc. have

taken place in the semi-arid West and Central Africa, farmers lack the incentives to produce beyond their family needs. There is, therefore, a need for the diversification of both agricultural production and products not only to broaden market opportunities, but also to break the vicious circle of subsistence agriculture.

The involvement of the private sector to enhance the industrial utilization of food grains is being explored. OAU/STRC-SAFGRAD and Nestle established a cooperative agreement to promote cowpea improvement and production for industrial use. The Burkina Institute for Environment and Agricultural Research (INERA), partner of SAFGRAD, is one of the first NARSs benefiting in the evaluation of elite cowpea cultivars and related technologies in the commercialization of cowpea.

The collaborative program of Nestle/SAFGRAD/INERA started with exploiting eleven elite cultivars for their agronomic yield performance at on-farm level and determination of their physiochemical and quality characteristics. The goal of the collaborative program is to set up a reliable system for commercial production of cowpea. The activities included:

- Seed increase of elite cowpea cultivars: From each cultivar adequate amounts of seed was provided to Nestle for determining the physical properties, chemical composition and quality. Few cultivars with good potential for industrial use were identified.
- Commercialization of cowpea production: This involves on-farm verification trials at Pobe (Sahel zone), Ziniare (Sudan Savanna) and Diebougou (northern Guinea Savanna zone). This aspect of research required the packaging of new cowpea production technologies to fit the level of resources and technological capacity of farmers.

More than 45 farmers are cooperating on the verification trials as well as cost of cowpea production at Pobe (Sahelian zone). The production determinants include integrated pest management, seed production, fertilizer price and application, labor costs for land preparation, weeding, harvesting, transport, and marketing.

Farmers are cultivating improved cowpea varieties in monoculture on relatively large areas, since they are assured of a market. On-farm production research looks into lowering the total cost of producing cowpea to ensure high returns, an important factor in adopting technologies.

The availability of multi-resistant cowpea cultivars to insect pests and diseases reduced the frequency of insecticide spray by at least 50 percent. As depicted in Figure 1, yield increases from 68 to 133 percent were apparent (compared to unsprayed fields) for single and two sprays of insecticides respectively, in the high insect infestation zone (Central and Eastern region of Burkina). The same trend of yield gains, 73 to 113 percent, was attained from single and two sprays of insecticide respectively, compared to unsprayed fields in the Sahel zone.

CONCLUSIONS

- A successful commercialization of the technologies resulting from on-farm research is a necessary condition for the quantum leap that is needed for agriculture to assume its role as food provider and overall economic development enhancer in West and Central Africa. Such large scale commercialization can be best achieved by the private sector, but there are prerequisites to its success.
- The first prerequisite is an adequate institutional framework. At present, agricultural services are dominated by public agencies. An attempt to quickly replace the parastatals with the private sector runs the risk of taking agriculture backwards. In fact, the transition must be smooth, and care should be taken to ensure that the private sector has the technical knowhow to commercialize and service key technologies, and that the legal framework allows the control and monitoring of the whole process. Private merchants left to themselves are likely to be tempted to commercialize uncertified varieties of fertilizers to exploit farmers.

- The second set of prerequisites are economic. A sustained adoption of a technology will only occur if it is profitable for all actors involved, the sellers and the users. Profitability and stability of the market for the end product are key elements to sustained adoption. A combination of private and public initiatives should be put in place to allow end product market efficiency. The necessary fiscal system should for instance be defined to promote the local or sub-regional demand for the products for which the technology is intended. The example of the cowpea venture by Nestle through SAFGRAD/INERA and farmers in Burkina is illustrative of this point. Likewise, efficiency of the input market will reduce costs and increase the likelihood of input sales.

Implications for Further Research

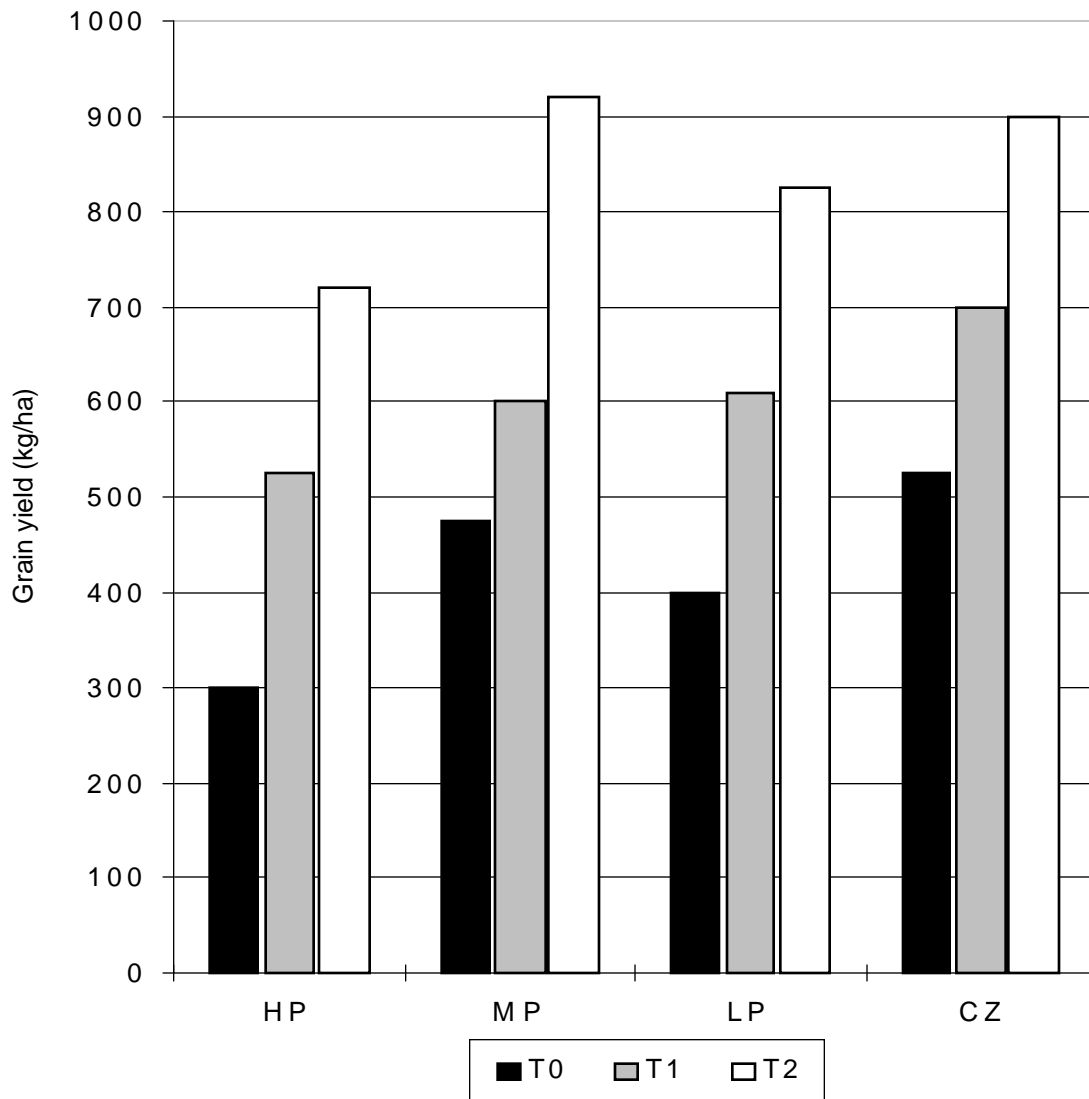
Knowledge gaps to reach the ultimate goal of a successful technology commercialization exists at three levels: the technology market; the output market; and the required institutional setting.

With regard to agricultural inputs and technology, careful research is needed on both the demand and supply side.

On the technology demand side, research could address the following:

- an inventory of existing technologies related to promising crops;
- repackaging of technological components to reduce cost of production, marketing, etc.; and
- an assessment of the profitability of various technologies under real farming situations. This includes the careful assessment of the costs of production of crops using the technologies and the other micro and macro constraints faced by the producers using the technology. Constraints include access to inputs through credit or cash and the unavailability of labor. An illustration of this is the current Nestle/SAFGRAD/University of Ouagadougou collaborative work to estimate the industry gate cost of cowpea technology, through a careful assessment of marketing costs of production. The same type of study may be useful

Figure 4.1. The Effect of Insecticide Treatment on the Yield of Cowpea Cultivated in Different Insect Pressure Ecological Zones of Burkina Faso



Legend

T0 - Without insecticide spray
T1 - Single insecticide spray 30-35 days after planting
T2 - Second insecticide spray 50 after planting

HP - High insect pressure zone (Kvx396-4-4)
MP - Medium insect pressure zone (KN-1)
LP - Low insect pressure zone (Goron local)
CZ - Cotton cultivation zone (KN-1)

for other crops such as maize and peanut.

On the technology market and supply side, the following should be addressed.

- What are the actors currently involved (parastatals and private entrepreneurs)?
- What is the potential market size?
- How does the market function? Are there inefficiencies that could be removed?
- What are the constraints presently faced by private entrepreneurs, with respect to supply sources and sale of products or services?

With regard to the product market, there is need to:

- assess current demand, including domestic and sub-regional or international sources;
- assess potential demand, through prospecting new markets or the processing of products; and
- evaluate the functioning of the product market and identify whether there are inefficiencies that can be removed through private or public actions.

With regard to institution building, two points should be considered.

- The major knowledge gap concerns the appropriate way of phasing out the public sector to ensure a smooth transition to the private sector in the area of inputs delivery and services.
- Research on alternative ways to the public and private handling of inputs should be undertaken. These include enabling and organizing farmers to assume the technology transfer and inputs delivery services.

To address the above issues, a pilot project or study can be undertaken in a few countries.

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Empowering Africa in the Information Age by Lane Smith, Leland Initiative Coordinator,
USAID/AFR/SD/SA, Department of State, Washington, DC, USA

Abstract

The purpose of the Leland Initiatives Telematics is to work with 20 or more African countries to establish the Internet and apply its benefits to the challenges of sustainability. The objectives are to provide affordable Internet connections with free and open access through private sector viable Internet service providers as well as establish a capable and expanding user base. Negotiations with bilateral agreements for Mali, Madagascar, Rwanda, Mozambique, Eritrea, Ethiopia, Kenya, Ghana, Benin, Ivory Coast, and Guinea-Bissau are underway. The process of establishing a gateway through the use of equipment, training, policy

analysis (specifically tariffs and regulatory agencies) is in progress. Two other processes in progress include the establishment of an Internet society and the preparation of a country plan by assessing Internet readiness of USAID and cooperating partners. Indicators necessary for the successful implementation of the project include: institutional information and communication strategy; current production and use of information; awareness of the Internet by the prospective clients; an Internet champion; and potential for sustainability.

AfricaLink: Providing Electronic Connectivity to Agricultural and Natural Resources Management Research in Africa by Michael Hailu, Information Officer, International Center for Research on Agroforestry (ICRAF), Nairobi, Kenya

Abstract

One of the most critical constraints limiting the effective exchange and dissemination of agricultural information in Africa is the absence of reliable electronic mail and Internet facilities, especially outside of capital cities. Advantages of electronic mail services include speed, affordability, reliability even on bad telephone lines, delivery of text in electronic format, and provision of services such as e-mail, fax, file transfer, electronic conferences, bulletin board systems, and remote database access. Factors that seem to slow down the development of the Internet in Africa are poor telecommunications infrastructure, unfavorable regulatory environment, lack of trained manpower, and low level awareness among policy-makers.

With funding from USAID's Productive Sector Growth and Environment Division of the Africa Bureau, ICRAF launched AfricaLink to facilitate and improve electronic mail connectivity to East African National Agricultural Research Systems (NARSs). The primary targets of the project are agricultural and natural resources research networks operating in the 10 member countries of the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA). Although the project primarily targets individual researchers, institutional connectivity has also become important to ensure sustainability and more extensive use of the technology.

The key guiding principle in implementing AfricaLink is to rely and build upon local capacity, where it exists, to provide connectivity. This will ensure sustainability and promote local Internet service providers.

AfricaLink's support to partners typically includes the provision of e-mail connectivity, training, supply of modems and communication software, and payment of a one-year subscription. The first task in implementing AfricaLink was to identify research networks that would benefit from e-mail connectivity. A total of 250 members of 14 agricultural and natural resources management research networks were identified. The next step was to explore connectivity options in each of the countries by identifying existing local Internet service providers (ISPs) and where they do not exist, look for other possibilities to implement connectivity.

So far, over 150 AfricaLink partners in Ethiopia, Kenya, Madagascar, Tanzania and Uganda have been provided with e-mail connectivity. Plans are underway to extend connectivity to more partners in the five countries already covered as well as in Eritrea and Rwanda. A regional help desk has also been established at Makerere University in Uganda to provide training, trouble-shooting, and technical backstopping to AfricaLink partners and local service providers.

Theme III Summary of Discussions

Chair: Maria Mullei, Program Specialist, USAID/Kenya

Rapporteur: Kwesi Atta-Krah, Regional Coordinator, ICRAF, Nairobi, Kenya

Moderators: Bakary Kante, Director of Environment, Ministry of Environment, Senegal; Conrad Bonsi, Associate Research Director, Tuskegee University, Alabama

Reporter: Walter Knausenberger, Environmental Advisor, USAID/AFR/SD/PSGE/ENV

A sharing of technologies and information within and among countries can accelerate the transfer and commercialization of agricultural technologies.

Given the growing integration of economies and the levels of collaboration in research and development processes, clear rules are needed regarding the ownership of new technologies and the distribution of economic returns from them.

Intellectual property rights promote the invention of technologies, protect the interests of inventors and investors, and promote the use of inventions/technologies. Local instruments or laws include patents, trademarks, and copyrights. Patents and other measures could assist in the sustainable financing of agricultural research by generating funds from royalties.

Having an appropriate legal framework in place is a first step, but a credible, well-functioning legal system is needed to implement the laws.

Major problems in the area of intellectual property rights include a lack of public awareness, a lack of know-how in adapting and commercializing technologies, the costs of licensing, and an absence of links between inventors and investors. Many people do not know that patent offices and free access to patent information exist in their own countries. Inventors themselves are unfamiliar with trademarks and methods of creating a value-added market image

for their inventions. Unsuspecting inventors and even public policy makers enter into license agreements with little or no knowledge of the consequences of what they have signed.

In developed countries, there are well-established service support sectors that provide technical, marketing, and financial support to help inventors and to assist in transforming inventions into salable commodities. African countries do not appear to have these necessary support sectors.

Given the growing integration of economies and the levels of collaboration in research and development processes, clear rules are needed regarding the ownership of new technologies and the distribution of economic returns from them.

Numerous examples of successful commercialization and transfer exist in Africa. For example, numerous animal vaccines used in Africa are available because the pharmaceutical companies that invented them were able to

patent them and then license African partners to manufacture and use them. Equipment for improved tillage, of Ethiopian origin, is now in use in more than a dozen countries, in part through the promotion created by its having been patented. Many of the rose varieties being exported to Europe have been patented, increasing their marketability and niche in that market. The introduction of a leguminous tree species, *Callimidra calotliysus*, as an alternative protein source for dairy cows, has helped to reduce the reliance on commercial dairy meal and increased milk production and profitability for smallholder farmers in the highlands of Kenya. Transfer of this technology was through effective partnership between research and government extension systems.

Issues relating to the protection of African plant and animal resources could be addressed through intellectual property rights.

Information sharing is a multidirectional process that can be achieved by the use of a combination of mechanisms of dissemination. Throughout Africa, there are numerous examples of information sharing and dissemination tool that facilitated technology transfer and commercialization. For example, FAO facilitated the transfer of the Chorkor Smoker, a local technology for smoking fish. Transfer was accomplished through training, face-to-face interaction, and community mobilization.

The Leland Initiative and AfricaLink are two current efforts to increase information sharing and dissemination through Internet linkages. Services available include e-mail, electronic conferences, bulletin boards, file transfer, and interactive services.

RECOMMENDATIONS

- Governments should take the initiative to raise public awareness of intellectual property rights issues, for example, by sponsoring invention competition and by supporting the creation of product development centers to help fill the gap between inventors with good ideas and investors with the money and connection to market inventions. Opportunities exist for the private sector to share the risk and cost of such initiatives.
- African governments should address the infrastructure, human resource capacity, legal and regulatory constraints affecting information and communication systems. Electronic communication offers multiple opportunities for training, information sharing, and dissemination to accelerate technology transfer and commercialization.

5. Plenary Session IV

Theme IV: Access to Inputs

Topic I: The Mechanisms for Promoting National/Regional Seed and Planting Materials Industry

Chair: Mortimer H. Neufville, Vice President, Academic Affairs, UMES

Rapporteur: Menwuyellet Moussie, Technology Transfer Advisor, USAID/AFR/PSGE/TDT

Technology Development, Transfer and Commercialization: The Experiences of the Kenya Seed Company, Ltd. by Nathaniel K. Tum, Managing Director, Kenya Seed Company, Kenya

Abstract

The Kenya Seed Company Limited was incorporated in 1956 under the laws of Kenya. The company started as a small pasture seed concern but has since diversified to production of various seeds including hybrid seed maize. The company operates on purely commercial basis sourcing its funds from the local commercial banks and repaying the same from the seed sales proceeds. The company interacts with government, farmers, trade unions, technology suppliers, and competitors within the seed industry. The company has a board of directors consisting of nine members, i.e., the Kenya government, the Kenya Farmers Association and individual farmers who own the share capital of the company. The company management consists of the Managing Director, his deputy and other management staff and general labor totaling 635, spread countrywide.

The initial objective of the company was to cater to the seed requirements of the settler farmers with regard to pastures, sunflower, and later wheat and maize. Seed maize is the largest of the crops produced and marketed by the company. In fact, the story of the seed maize production by the company represents the story of the gradual rise, commercialization and transfer of agricultural seed technology in the company and in Kenya. Starting with a meager three tons production and sales in 1963, Kenya Seed Company today produces and markets more than 22,000 tons of seed maize annually.

The year 1995/96 has seen the emergence of a new wind of change namely “liberalization.” The liberalization of the economy in Kenya has brought with it several benefits including competitiveness and efficiency, but it has also brought with it several constraints and hardships. Kenya’s agricultural economy depends a lot on procurement of inputs such as fertilizer. Unfortunately, fertilizer in Kenya is imported and is affected by regular fluctuation of foreign currency rates.

The importation of cheap cereals, including maize, from cheap sources has also affected the local agricultural sector’s performance in that it discourages farmers from growing more when the prices are low.

The company has adopted a marketing strategy that will ensure a lion’s share of the market of maize, wheat, barley, pastures, and horticultural products. It has put in place an extensive distribution network which has been operational for many years. These networks are composed of manufacturers, farmers associations agents and sub-agents, stockists as well as farmers.

It would be presumptuous to think that Kenya Seed Company has had only success stories. The company has experienced several constraints which include the following:

- fluctuation of seed maize production under rainfed conditions;

- emphasis on promoting the use of hybrid seed maize locally (current adoption rate is 60 percent);
- lack of suitable institutions for manpower training in seed technology;
- market fluctuations of demand and supply for seed;
- too high interest rates (20-34 percent) discouraging borrowing and possible expansion of the seed industry; and
- low purchasing power of the farmers which is tied up with the overall return on their investment.

Government controls on importation and exportation of seed has improved since the liberalization of the economy, but will require more attention with regard to local environment and policy matters that affect the seed industry.

Technology Development, Transfer, and Commercialization: The Experiences of the Seed Company Ltd. of Zimbabwe by J.A. Durling, Chief Executive, Seed Company Ltd. of Zimbabwe, Harare, Zimbabwe

Abstract

The Seed Company's origin goes back to 1940 when a group of farmers formed the Seed Maize Association in order to multiply and market open pollinated maize varieties. Research on breeding hybrid maize commenced in 1932 at the government owned research station. The first commercial hybrids were released in 1947. In 1960, SR52, the world's first commercial single cross hybrid was released. In 1970, an agreement was signed with the government giving the Seed Maize Association exclusive access to government breeding materials. In 1973, the association purchased its own farmland where a mid-altitude research station was set up. In 1983, the Seed Maize and Crop Seeds Associations formed an alliance to set up the Seed Cooperative Company of Zimbabwe Limited. The Seed Coop, as it was popularly known, was owned by 200 members, all of whom were seed producers. In 1996, a prospectus was issued whereby the public would have the opportunity to acquire 30 percent of the company, and the company would raise over US \$4.5 million from the share issues. Over US \$10 million were raised. Strategically, this move removed control of the single most important player in the national food production from just over 200 farmers to the public at large. It also significantly improved the financial position of the company. Another important feature of the company is its strategic alliance with DeKalb Genetics Corporation of the United States. DeKalb took up a special allocation of shares equivalent to 1.5 percent of the company. Potential investors saw this as a major strength while the small amount of the allocation gave the company comfort that there was no intention by DeKalb to swallow up a relatively small organization.

The Seed Company develops and markets certified crop seeds. Sales are mainly of hybrid seed maize, but there are significant sales of wheat, barley, soybeans, sorghum, and groundnut seed. The seed is

produced under contract by an established producer network from parent seeds owned and supplied by the Seed Company. Annually, the company sells around 50,000 tons of seed of which 35,000 tons will be hybrid maize. In volume terms, this makes it Africa's largest seed business. Between 1980 and 1986, small-holder maize production in Zimbabwe doubled and around 700,000 farmers moved from open pollinated seed to hybrid maize seed. Today, Zimbabwean farmers are almost exclusively hybrid seed growers, a claim that no African country can make. Currently, the company offers 19 maize hybrids which perform very well in much of sub-Saharan Africa and supplies Zimbabwe's needs for wheat and soybean seed. The company is now embarking on a policy to expand the business regionally by teaming up with partners who are already in the seed business or by doing it alone if need be. An important part of the exercise will be to develop and produce seed within the country in which the company is operating.

LESSONS LEARNED AND ISSUES TO BE RESOLVED

- First and foremost, the business has to be customer oriented or else it will not survive.
- There is an unfortunate record of African governments propping up national seed companies because they see them as strategically important.
- Competition should be encouraged. Zimbabwe has been operating as a closed economy for so many years, which resulted in the company's one hundred percent market share being eroded by new international players, which undoubtedly forced it to improve its business.

- Zimbabwe has the lowest seed prices in Africa, largely because the cost of resources, particularly research, is spread over a greater sales base.
- The Seed Coop was fortunate in having exclusive access to government research in the early years. However, if it had not had the vision to set up its own research many years back, it would not have been in its current position.
- There has been a strong tendency to set in place government certification and registration requirements, primarily to protect consumers. This is an expensive and time wasting process. Moving to a regionally common list would fulfill this requirement. Once a hybrid is registered in one country, it should be good for all countries. There could be a register of approved seed producers and traders rather than their products.
- Free seed handouts are a contentious issue. There is a real danger that the customer ends up with a product that is not his first choice. Furthermore, there is no long-term establishment of a viable trader base. Something like a seed voucher needs to be looked at.
- For technology to be most effective, it must be fully commercialized.

Topic II: The Mechanisms for Promoting Livestock Industry

Experiences with Innovative Approaches to Transfer and Commercialization of Technologies Related to Livestock and Dairy by J.W. Smith, K. Agyemang, and S. Tarawali, International Livestock Research Institute (ILRI), Nairobi, Kenya

Abstract

The senior author opened the presentation by quoting Derek Bribie (1994) who stated that “The challenge we all face today is learning how to produce higher yields of crops and livestock while still conserving essential natural resources like soil, water, forests, and biodiversity which will be needed for the survival of future generations.” Livestock research in developing countries includes basic, strategic, applied, and adaptive research. Such research approaches have global, eco-regional, and national or local relevance. Livestock’s contribution to agricultural gross domestic product (GDP) excluding manure and traction by regions is: developed countries (50 percent), sub-Saharan Africa (25 percent), South America (38 percent), and Southeast Asia (22 percent). Agricultural domestic product in sub-Saharan African countries (1986) as percent of gross national product (GNP) ranges from 3.4 (Angola) to 68 (Uganda). The corresponding figure for labor force in agriculture ranges from a low of 4.5 percent (Botswana) to 86 percent (Mali).

The estimated 1998 population and corresponding meat and milk output for sub-Saharan Africa are: human population (498 million), cattle population (162 million), sheep and goats (270 million), milk output (8.2 million tons), and meat output (3.257 million tons). The corresponding figures for the year 2025 are estimated to be 1,294 million, 239 million, 945 million, 35.6 million, and 11.223 million, respectively.

The contribution of ruminants to farming include food and nutrition, food security, manure, traction, moving bank as well as social and ceremonial status.

Adoptable technologies should be simple and flexible. Benefits must be obvious and immediate, must be responsive to multiple constraints, cost should be low, should be scale neutral and compatible with social norms and traditions. Methodological approaches for innovative technologies should include a description of existing systems, constraints, research opportunities, component research, validation of alternatives and ex-post analyses.

Using the farming systems approach, ILRI in collaboration with other collaborators, has experiences in alternative technology development in fodder banks, alley farming, broad-bed markers, trypanotology, vaccine production, zero grazing for milk production, internal agitator, cow traction, legume farming, and endoparasite resistance.

Technology testing/validation has been conducted on trypanotology, zero grazing, cow traction, and legume farming while technology transfers have been effected in fodder banks, alley farming, broad-bed markers, zero grazing, internal agitator, and cow traction.

The technology for fodder banks has been generated in an attempt to overcome the scarcity of dry matter during the dry season, increase the nutritional value of feed and accrued benefits to subsequent crops. The fodder bank technology was developed with the main purpose of overcoming dry season feed constraints by conserving high quality forage produced in the wet season for use in the dry season. Severe dry season feed constraints are characterized by low feed quantity and quality, animal weight loss and very low milk production, poor reproductive performance resulting in low calving rates and long calv-

ing intervals. Fodder banks eliminate or minimize loss in livestock performance during the dry season, resulting in weight gain, increased milk production and reproduction. They also contributed to subsequent crop production by enhancing soil organic matter and fertility.

Ex-post issues of commercialization of technologies include the following:

- Pasture crops are not given the same status as food crops, hence the reluctance to protect them.

- Single species pastures were not sufficiently robust.
- Alternative utilization strategies include dry season as well as wet season supplementation (small ruminants and cattle).

Methodological issues which arise include choice of test and control farms, statistical issues, components of models, technology transfer issues, monitoring efficiency, and testing validation transfer.

Topic III: The Role of Post-harvest (Processing) Technologies in the Transfer and Commercialization of Agricultural Technology

The Experiences of the Institut de Technologie Alimentaire (ITA) in Post-harvest (Processing) Technology Generation, Transfer, and Commercialization by Ousmane Sy, Chief, Technology Development Division, ITA, Senegal

Abstract

The Institute of Food Technology (ITA) is a public and applied food research center created in 1966. Its main objectives are the popularization of locally produced food through developing new products and food preparation methods, preservation, storage, and transformation. ITA also provides technical assistance to small and medium scale industries, private promoters and farmers. It also is engaged in training technicians.

Research carried out in the different food sections has led to the creation of new activities and the establishment of processing plants in rural areas of small and large scale industries. Products and technologies are disseminated and transferred by using several methods in the form of projects, product diversification, quality improvement, and training of technicians of private promoters. However, several difficulties have been encountered in the transfer of these technologies. These include lack of well organized extension systems, communication between

research, extension and farmers, credit facilities, raw materials, and high cost of equipment.

Research plays an important role in improving food production in Africa. However, research programs must be based on the needs of the users such as farmers, promoters, and industrialists. In turn, these users should also help finance appropriate research. Credit facilities and financial support are also crucial for technology transfer.

ITA's new strategic planning defines priorities to optimize the use of its product through appropriate research development and technology transfer, assistance to local industries in adopting and/or adapting local and international quality standards, technical assistance in reducing post-harvest losses, industrial quality control policies, and training of technicians.

Last but not least, it is very important to establish communications channels between researchers, extension workers and end-users of research results.

Availability and Accessibility of Processing Equipment for Technology Transfer and Commercialization by Charles Boaitey, President, Adeemera Enterprises, Inc.,
Penfield, New York, USA

Abstract

Adeemera Enterprise, Inc. was established in June 1983. It is dedicated to the promotion of the growing needs of agribusiness in developing countries both in rural and urban areas by reducing labor intensive aspects of food production in developing countries. Adeemera Enterprises, Inc. believes that modernization of farming techniques is essential to the economic strength of developing nations all over the world. Mechanization of the labor intensive aspects of food production, whether it be the processing of dehydrated food stuff for human consumption or preparation of grains for livestock feed, is a process that can have a positive impact. Its machine design criteria include simplicity, durability, portability, user friendliness, minimum maintenance, productivity, high quality, cost effectiveness, and versatility.

Two types of products are designed by Adeemera Enterprise, Inc., i.e., Adeem 500 portable grinder and

Adeem 300 CP. The Adeem 500 portable grinder is made of stainless steel plate which can be used for flour processing of maize, wheat, millet, rice, soybeans, sorghum, peanuts, cassava, as well as coffee and sugarcane. It is capable of producing more than one ton of livestock feed per hour. Adeem 300 CP processor is also made of stainless steel plate for grating cassava, yam, plantain, and other food ingredients. A farmer or food producer can process fresh cassava for the production of gari, attake or the extraction of starch for both local and export market.

The main constraints are lack of marketing, the high cost of borrowing, and government bureaucracy. The opportunities exist for global marketing increase in machine manufacturing, increase in export, and helping the growth of rural economies in developing countries.

Food Technology Research in Côte d'Ivoire: The Experiences of Côte d'Ivoire Tropical Technology Company (I2T) in Generating and Transfer of Agricultural Technology by Yeo Guefala, Deputy Director for Research and Development, I2T, Côte d'Ivoire

INTRODUCTION

Côte d'Ivoire, like many African countries in the intertropical zone, has based its development on agriculture. In 1995, agriculture accounted for approximately 70 percent of its export income due to the fact that the country has concentrated on developing export crops such as cocoa, coffee, cotton, pineapples, etc., in order to earn quick funds to finance socio-economic infrastructures. The proceeds from the sale of these cash crops also allowed food to be imported to meet the needs of the urban population, whose eating habits have been influenced by Europeans.

The risk of exporting commodities whose prices fluctuate and of importing finished products at a higher price became clear when Côte d'Ivoire became independent; consequently, an industrialized policy was adopted to develop agricultural products and reduce imports.

THE FOOD INDUSTRY

Two main industrial categories have been developed. The first category includes industrial crops that are used locally to manufacture finished products that can be substituted for imports. This category includes:

- the palm oil industry to replace peanut oil;
- the sugar industry, using sugar cane;
- the brewing industry to make beer locally from imported raw materials (malt, hops, corn, grits, etc.);

- the grain industry, particularly the use of wheat to make flour for bread bakeries, the cookie industry and local pastry shops; and
- the textile industry.

The second category is geared towards the export industries that increase the added value of agricultural products for export. This category includes:

- industries for the initial processing of coffee (shelling) and cacao (manufacturing cocoa butter and cakes);
- the canning industry for pineapple (canned fruit and juice) and tuna;
- industries for secondary processing of coffee (instant coffee) and cocoa (chocolate, etc.);
- the coconut processing industry (copra oil and grated coconut);
- the cotton industry (ginning); and
- the lumber industry.

Overall, these industries have developed because of a favorable environment that includes the existence of both local and export markets and the availability of needed technologies from the industrialized countries. The above industries did not have to develop new technologies or seek to promote new products. This led to a situation where the same level of industrialization did not exist for the so-called subsistence crops, particularly manioc, yam, plantain, millet, and maize. Technologies to process these subsistence crops should be developed to make the products suitable for urban consumption. Research efforts have concentrated on the industrial food sector, due to its importance in the economic and social development of Côte d'Ivoire.

DEVELOPMENT OF FOOD TECHNOLOGY RESEARCH

Immediately after it gained its independence, Côte d'Ivoire initiated technological research policies in the processing of agricultural products. The Institute for the Technology and Industrialization of Tropical Agricultural Products (ITITAP) was founded in 1962 (two years after independence) and was responsible for:

- research and dissemination of information on technologies for processing agricultural products;
- training of technicians;
- implementation of research projects;
- technical assistance to various industries; and
- industrialization of sectors with potential economic viability.

ITITAP obtained interesting results through feasibility studies on the processing of agricultural products. The best known products are:

- palm wine stabilized in cans;
- extraction and stabilization of palm nut pulp to make it easier to prepare the traditional sauce, which requires the nuts to be crushed by hand;
- precooked yam and plantain flours for reconstitution of foutou particularly in cities;
- dehydrated atti; and
- extraction of milk and virgin oil from coconuts using a wet process.

But none of these results was truly able to proceed from the laboratory stage to that of industrial development. The reasons cited were that the stage at which the results were obtained did not provide sufficient guarantees for promoters with regard to both industrial feasibility (reproducibility of results) and economic and financial profitability. The promoters felt that the risks were too great and that the results would have to be tested at the pre-industrial stage to ensure reliable data. ITITAP did not have the technical and financial means at its disposal to progress to that stage, and it ceased operating in 1997.

The projects initiated by ITITAP were taken over by the Department of Tropical Technology (D2T) of Oil Palm Development Company (SODEPALM). Due to its involvement in the extraction of palm oil, D2T had gained experience as a consultant which enabled the design and creation of industrial pilot units to test the feasibility of the product developed by ITITAP. Projects such as the manufacture of dehydrated atti were resumed, and pilot units were built.

In 1979, the SODEPALM group was divided into several units. The Department of Tropical Technology gave way to the Côte d'Ivoire Tropical Technology Company (I2T), whose founders, having learned from the experiences of ITITAP, wanted to create an instrument for the promotion of industrial projects by choosing the legal form of a mixed economy that associated the State of Côte d'Ivoire with the French Development Fund (TECHNIP) and the Atomic Energy Commission. In 1982, the State of Côte d'Ivoire supplemented the research structure by founding the Ivory Coast Technological Research Center (CIRT) to continue the activities of the former ITITAP. It had soon become clear that I2T could not cover the entire field of technological research on its own.

After 17 years, I2T has been able to accumulate a great deal of experience that enables it to propose projects to the government for better guidance of technological research and better development of research results.

EXPERIENCES OF I2T IN THE AREA OF TECHNOLOGICAL RESEARCH

Facilities

As stated above, the establishment of I2T fulfilled the need to provide industrial credibility for the results of applied research in the laboratory. To meet this objective, I2T created a structure and organization by setting up pilot units to:

- test the technical reliability of equipment and processes;
- determine production costs to establish the economic feasibility of processes and equipment; and

- do market impact studies by supplying commercial samples of stable quality.
 - I2T created a test platform that had:
- a consulting office for industrial design and economic and financial project studies;
- a mechanical fabrication workshop to build prototypes and make pre-series versions of some equipment;
- a quality control and sensory analysis laboratory; and
- documentation for the collection of scientific and technical information.

It also created an industrial test site for manioc in Toumodi, about 200 km from Abidjan, the capital city of Côte d'Ivoire.

Accomplishments of I2T

I2T was able to develop various process and types of equipment using the facilities described above. The company developed and tested on a pilot scale various processes and equipment for processing agricultural products and by-products which includes the following.

- Process to produce flour from manioc at a rate of 400 kg/hour: The flour was used by bakers to make local bread with 10 percent manioc flour. Even at this low rate, the operation was profitable for the bakers because they were able to save money on the production process.
- Process to convert manioc into a precooked, dehydrated semolina commonly known as "atti" finished product: The dehydrated product is not well accepted by consumers in Côte d'Ivoire. It has no particular advantages over the fresh atti product which is very popular in the countries of the sub-region. To satisfy the needs of the consumers, I2T has developed lower capacity equipment to produce fresh atti for sale on the local market, with a production capacity of 500 to 1,500 kg atti/hour.
- Production of biogas from manioc peels: A digester with a capacity of 1,200 cubic meters has been built.

- Process to convert manioc into starch using low capacity units: Experiments are being conducted on this line in response to a popular demand by promoters who would like to acquire such units to process manioc into starch.
- Industrial copra production process with a capacity of 1,000 kg/hour which produces energy by gasification of coconut fibers: This production has ceased operation due to the decline in the price of copra, which discouraged potential customers.
- Process to produce virgin oil and powdered milk from coconut: Customers have already begun testing these products using the samples produced by I2T.
- Carbonization of coconut shells in a furnace with a production capacity of 200 kg/hour activated carbon.
- Granulation of flours to manufacture couscous from millet, sorghum, and maize.
- Equipment units, such as a coffee sheller, manioc grater, and palm oil press, are being developed and tested.

Problems and Perspectives

The primary reason for the insufficient utilization of the research results is the lack of an appropriate structure to promote and develop the research results.

Marketing a new product or using a new technology always involves a risk, and promoters interested in using research results do not want to bear that risk alone.

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The results of studies on consumer tests based on samples produced on pilot projects do not sufficiently guarantee the existence of markets for larger quanti-

ties over and above that were actually sold. That is why several promoters interested in creating production units for new products would like the risks to be shared by I2T.

To overcome these difficulties, I2T has suggested setting up a structure to assist the promotion of research results by creating a Fund for Technological Promotion and Development which will contribute part of the financing needed to create an initial production unit for any new production or process. This type of structure exists in other countries such as India, with its National Research Development Corporation (NRDC) and France's National Agency for the Development of Research.

The second reason for the failure to transfer research results to the productive sector is related to the current industrial environment. As stated above, the industrial food sector is characterized by its ability to use imported technologies to process imported or local commodities for the export market. This type of industry has not required the assistance of the national research system, because in many cases local markets were protected (monopolies) and export markets were controlled by the multinational corporations to which those export industries belong. Of course the market situation is changing as policies are liberalized, but a local industry that uses national research results has not yet been created.

The difficulties encountered by project promoters, particularly small and medium sized companies in obtaining financing is the third factor that limits the transfer of research results to the productive sector.

The creation of an industry, whether large or small, is subject to the following requirements: completion of a market study; selection of a manufacturing process and equipment; completion of an economic feasibility study and financial profitability study; capacity to provide a portion of the financing; and provision of security to lenders.

Most small and medium sized companies and industries do not have the financial means to do market, technical, economic, and financial studies. Pro-

motors who come to I2T generally expect the company to provide its services free of charge. Therefore, at that level, I2T plays the role of a structure that provides assistance to small and medium sized companies and industries. But the promoters, whose only capital is an idea for a project, have difficulty financing their projects.

Since the abolition of the Development Banks, it has become difficult for small and medium sized companies and industries to have access to credit because the security required by commercial banks, the short repayment periods and high interest rates of such banks hamper the development of new industries that could use research results. Therefore, appropriate financial institutions for small businesses will have to be recreated. This serious difficulty could be resolved in the near future if and when the recently announced Agricultural Business Bank (Banque de Affaires Agricoles) is created.

CONCLUSIONS AND RECOMMENDATIONS

Based on the experiences of I2T in the area of research and the promotion of agricultural technologies, it appears that the following actions must be taken to promote the transfer of research results to the productive sector:

- Establish an appropriate structure to promote research results and participate in the financing of initial production units for companies that use research results so as to minimize promotion risks.
- Provide assistance to small and medium sized industries and companies in completing market, technical, economic, and financial feasibility studies.
- Create appropriate financing structures for small and medium sized companies and industries which would constitute a genuine foundation for industrial development in African countries.

Topic IV: Accessibility, Utilization, and Alternatives for Critical Production Inputs

Availability and Accessibility of Fertilizers for Medium/Small-Scale Farmers in Africa
by Sam C. Muchena, Managing Director, African Center for Fertilizer Development, Zimbabwe

INTRODUCTION

The performance of agriculture in most of sub-Saharan Africa during the last two decades is disappointing. Falling per capita production, increasing food imports, falling receipts for cash crops, growing indebtedness, rampant malnutrition, disease, and internal strife, present a gloomy scenario. For example, the highlights of the Southern African Development Community (SADC) Food Security Quarterly Bulletin (June/July 1995), summarize the situation in the Southern Africa Region over the past one and a half decades as follows:

- SADC's food security situation deteriorates as cereal shortfall worsens to 3.91 million tons.
- Maize production declines 42 percent to 11.4 million tons/year.
- Import programs remain insufficient to cover cereal deficit.
- SADC launched a joint appeal for international assistance.
- Drought relief and rehabilitation programs are set to continue in several countries.

The African Fertilizer Market Bulletin (July 1995), published by the International Fertilizer Development Center (IFDC) in Togo, states the following:

- Food stocks are down, prices are escalating.
- Food crisis hits 15 states.

The per capita food production in sub-Saharan Africa (SSA) has been decreasing unlike other regions of the developing world (Figure 1), creating serious economic and food security problems leading to heavy imports. As most countries of the sub-Sa-

haran Africa region cannot afford to import large quantities of food, improvement of yields in the small-holder farming sector offer the greatest potential.

The availability and accessibility of fertilizers constitute the weakest link for successful crop production. About 45 and 70 percent of the budget costs of the large-scale and small-scale farmers respectively is on fertilizers and lime (Table 1). In the case of the large-scale farmer, the percentage contribution of fertilizer costs is reduced because of farm machinery and equipment repairs and maintenance, labor, herbicides, etc. which seldom apply to the small-scale farmer.

The very slow growth of fertilizer use in SSA is largely attributed to unavailability; low and uncertain profitability; irregular rainfall patterns; weak input distribution systems; and lack of credit for small-holder farmers and input dealers.

THE ROLE AND USE OF PLANT NUTRIENTS

Most tropical soils in Africa are low in organic matter and inherent fertility. Frequently, nitrogen (N) is the most limiting nutrient as it is rapidly depleted in cultivated soils. The traditional bush fallow system allows the slow replenishment of nitrogen during the fallow period. There is also widespread deficiency of phosphorus in the soils of sub-Saharan Africa.

Population pressure has reduced the fallow period and contributed to a decline in soil fertility. Erosion from inadequately protected fields has exacerbated the problem. The use of inorganic fertilizers is the main source of additional plant nutrients. The rates of application of cattle manure or compost are

Table 5.1. White Maize - Gross Margin Per Hectare

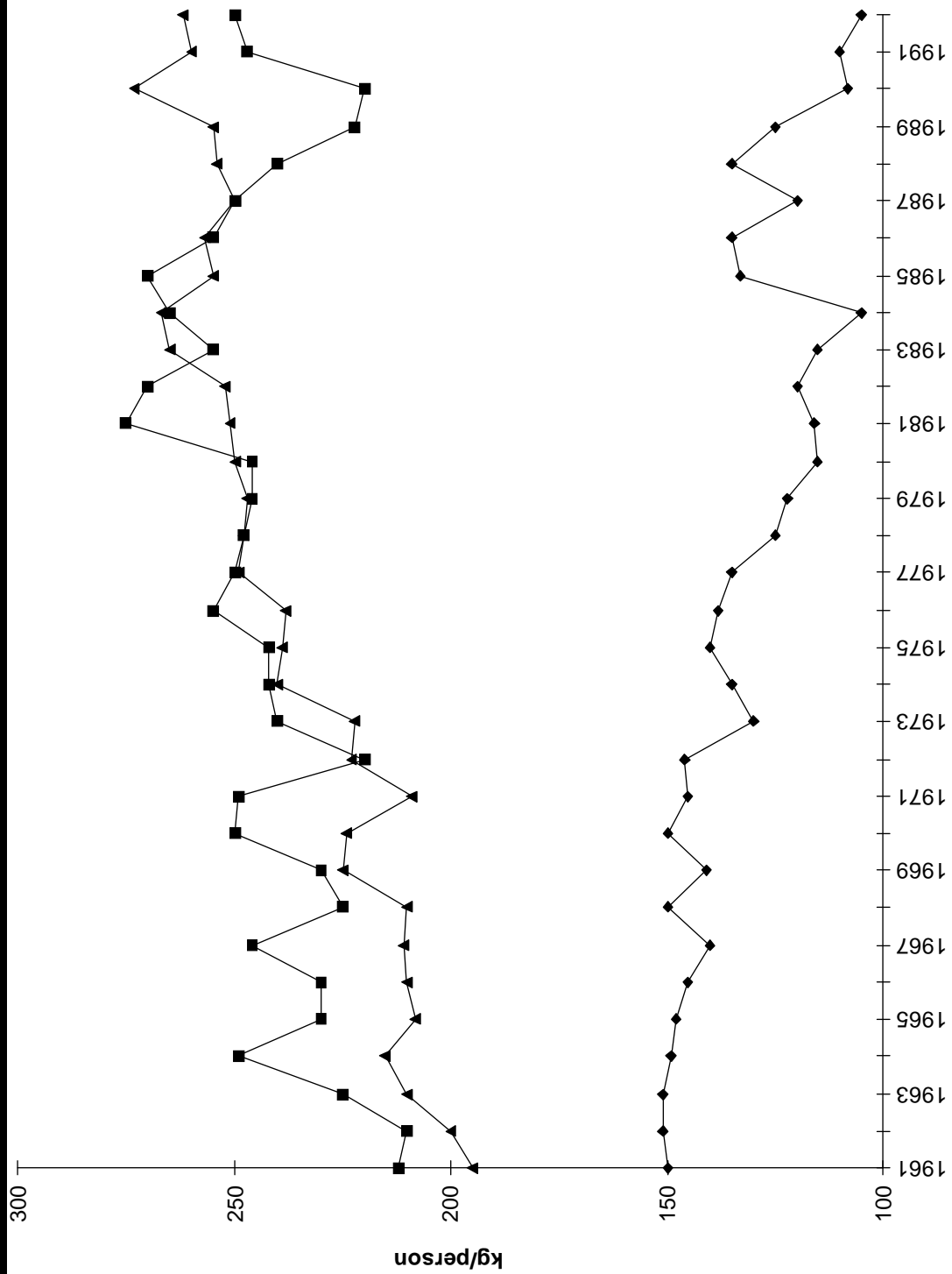
	Low yield 4000	Medium Yield 5000	High Yield 6500	Irrigated Yield 8500
Seed	111	121	135	145
Fertilizer	887	1,318	1,727	2,120
Herbicides	160	234	394	496
Insecticides	138	165	291	346
Labour	328	363	187	187
Fuel and Oils	116	116	168	168
Repairs and Maintenance	492	510	540	558
Aerial Spraying			107	107
Transport Out	150	188	244	319
Levy	57	71	93	121
Insurance	21	26	34	44
Combine			425	425
Irrigation				640
TOTAL COSTS	2,459	3,111	4,344	5,677

Table 5.2. Tanzania Input Available and Distribution for the 1990/91 Crop Season

Items	Units	Demand	Distribution	Distribution as % of Demand
1. Fertilizers	000 tons	175	86.9	49.7
2. Improved seed [*]	000 tons	12.6	0.1	0.8
3. Other agrochemicals in solid formulation	000 tons	5.4	1.1	2.0
4. Other agrochemicals in liquid formulation	million litres	6.07	1.48	24.4

^{*} Maize 535, Wheat 21%, Beans 11%, Sorghum and Millets 7%, Other seeds 8%.

Figure 5.1. Cereal Production per Capita - 1961-1992



Source: FAO

usually low, and the quality of these sources of plant nutrients is often poor. The potential usefulness of manure is often limited by cattle numbers. It is estimated that 10 cattle produce enough manure for one hectare of land. The growth of livestock numbers is limited by shrinking grazing land, frequent drought, and decline of biomass production due to soil degradation.

Sub-Saharan Africa has the lowest fertilizer use per hectare (Figure 2).

A wide gap exists between crop yields on small-scale farms (one ton) and large-scale farms (five tons/hectare). The reasons for this gap can largely be attributed to inadequate soil fertility management.

For example, a survey by the Zimbabwe Institute of Development Studies in 1990 showed that in the low potential areas (where some 80 percent of small-holder farmers live), inorganic fertilizer was applied on 20 percent of the farms. On average ten kg/ha of fertilizer are used in the small-scale sector of the SSA Region. By applying such a low level of plant nutrients, the small-scale farmers (constituting more than 90 percent of the farming community), often mine the soils of the major plant nutrients resulting in the decline of biomass production and soil degradation. The reasons for the limited use of inorganic fertilizers by small-scale farmers include problems of availability and accessibility. The demand is hardly satisfied in most of the SSA countries (Table 2).

Sub-Saharan Africa has the lowest fertilizer use per hectare (Figure 2).

Nobel Prize Laureate, Dr. Norman Borlaug, after many years of conducting more than 200,000 half hectare production plots in sub-Saharan Africa recently concluded as follows: We are convinced that if there is political stability and if effective seed fertilizer supply and marketing systems are developed, the nations of sub-Saharan Africa can make great strides in improving the nutritional and economic well being of their desperately poor populations.

Yields can be increased by 100-200 percent or even more in much of sub-Saharan Africa by improving efficiency all along the crop production line.

Opportunities exist in Africa to ensure that the farmers receive dependable supplies of the right inputs at the right time and at the lowest cost. What is needed is to remove the constraints that presently inhibit the supply and enlargement of the demand.

WHAT CAN BE DONE TO CHANGE THE PRESENT UNSATISFACTORY SITUATION OF FERTILIZER AVAILABILITY AND ACCESSIBILITY?

Opportunities exist in Africa to ensure that the farmers receive dependable supplies of the right inputs at the right time and at the lowest cost. What is needed is to remove the constraints that presently inhibit the supply and enlargement of the demand.

As demand is increased, more concrete plans could be made to use the abundant local raw materials to produce plant nutrients. The following are some of the steps that are needed to encourage industry to deliver the right kind of fertilizer at the right price and at the right time to the farmers.

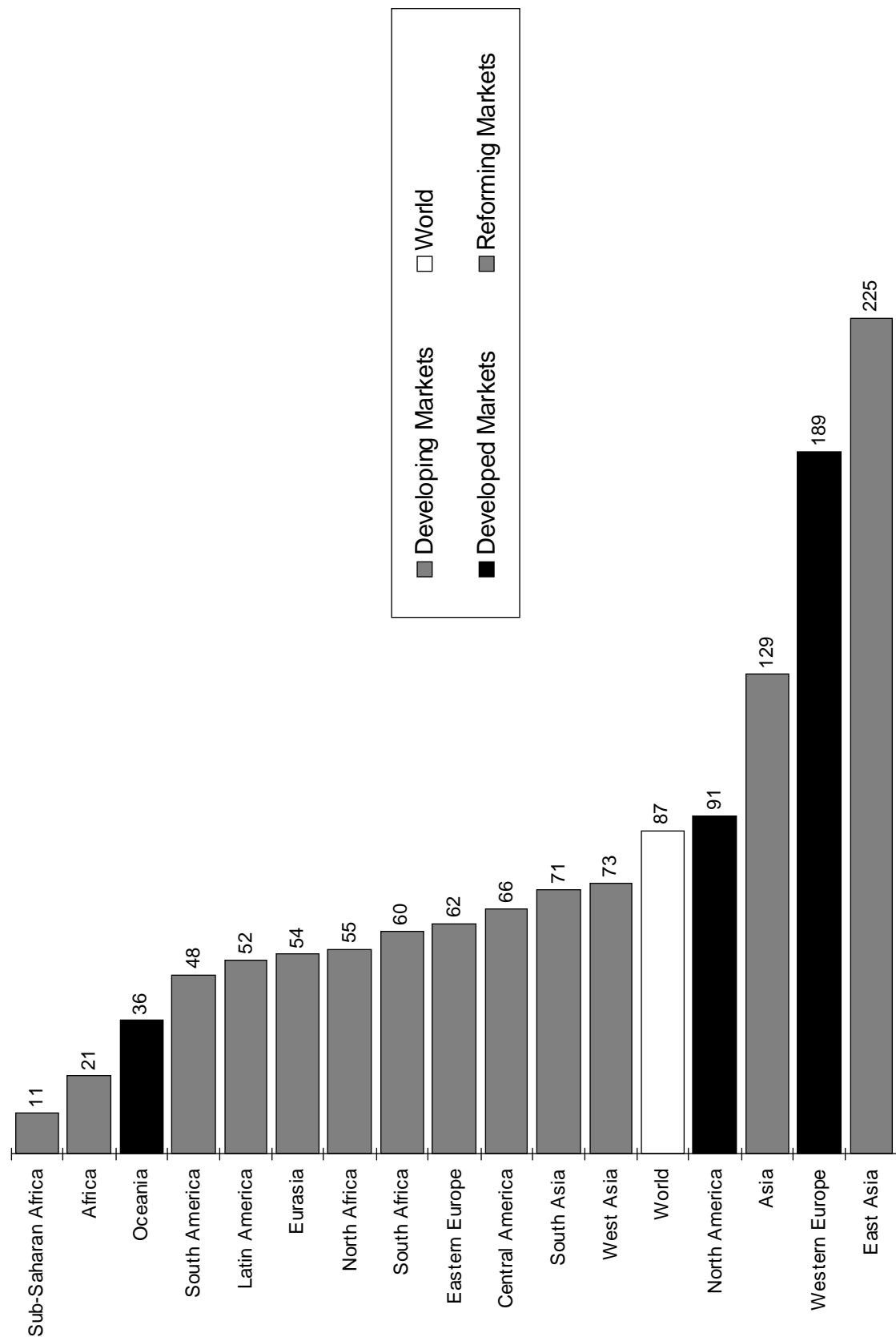
Improvements in Fertilizer and Other Inputs Information Systems

It is recommended that good data collection on fertilizer consumption, prices at all levels, fertilizer production by type and location and crop production, both past and planned, be systematically gathered and disseminated in each country. The establishment of an agri-input and advisory unit in each country should also be encouraged.

Improvements in Purchasing Practices

The idea is to get the cheapest supply from the world market. As can be observed in Figure 3, bargains can

Figure 5.2. Regional per Hectar Fertilizer Use (kg/ha)



be obtained at the appropriate time especially when big buyers are not coming onto the market. This, coupled with bulk buying, could reduce the cost of inputs considerably.

Selecting the Right Product Range

Fertilizer selection should be based on crop needs. Limiting the farmers' choice to fertilizers could lead to waste of nutrients. The ratios of nutrients applied should be fine-tuned as far as possible to crop requirements. The provision of efficient and effective soil and plant analysis services and a good product knowledge would help enable the farmers to realize the real value of fertilizers.

Establishment of a Revolving Fund

Such a fund would provide a basis for permanent working capital needed by the participants in the fertilizer supply and demand chain, i.e., producers, exporters, importers, distributors, and the farmers. A revolving fund can be set up by involving the commercial banks, development banks, and other financing organizations together with the participants. There are a few countries in the region which are already establishing revolving funds. In principle, financing the investments and working capital should not be difficult, given the large savings that can be realized and the possibilities for bilateral fertilizer aid. It is probably more prudent to establish a fertilizer revolving fund than a food reserve fund. As Edouard Saouma, former Director General of FAO, once stated, "Farmers in the Third World do not need grain, they need fertilizers."

Improvements in Distribution

A strategy should be worked out to develop and maintain an efficiently managed network of competent and knowledgeable dealers throughout the cropping areas of Africa to supply and service the fertilizer and other input needs of all categories of smallholder farmers. This is how India and Bangladesh achieved self sufficiency in food production. The African Center for Fertilizer Development (ACFD) has prepared a regional project in Southern Africa to facilitate input distribution through the development of small business entrepreneurs or dealers. The project,

if properly implemented, is expected to more than double the current levels of fertilizers reaching the small-scale farmers.

Fertilizer Resources and Production in Africa

Fertilizer raw material resources, especially phosphate, carbon, and gas, are abundant in the African region. For several reasons serious exploitation is confined to North Africa, a couple of West African countries (Nigeria, Senegal), South Africa, and Zimbabwe (Figures 4 & 5). For the rest of the SSA countries, the few fertilizer plants are either not in production or are working inefficiently. Domestic production accounts for a small fraction of the fertilizer used, the rest being provided from imports. Problems associated with procurement, such as availability of funding, are most critical.

According to the analysis conducted by the International Food Policy Research Institute (IFPRI) and the International Fertilizer Development Center (IFDC), the presence or absence of fertilizer raw materials does not seem to influence fertilizer consumption, but fertilizer production is positively associated with levels of fertilizer use (Figures 6 & 7). The supply side plays a decisive role in raising fertilizer use. What is needed for Africa is a strategy that combines aggressive resource development and importation. This is how China became one of the largest cereal producers (Borlaug, 1994). China is a large producer and also one of the largest importers of the major nutrients.

Holistic Approaches for Soil Fertility Improvement

Taking into account the severe climatic conditions, soil, and other natural constraints of African regions, food self sufficiency and food security for all is only achievable through the application of technology and scientific management. The 200,000 half hectare demonstration plots conducted by the Sasakawa Global-2000 Project and 350,000 trials and demonstrations on farmers fields, conducted by the Food and Agricultural Organization (FAO) in Africa over many years, have shown that yields can be increased by large margins in much of sub-Saharan Africa through combined technologies including proper fertilization.

Figure 5.3. Monthly International Urea Prices, 1983-1993 (Bulk, FOB US Gulf)

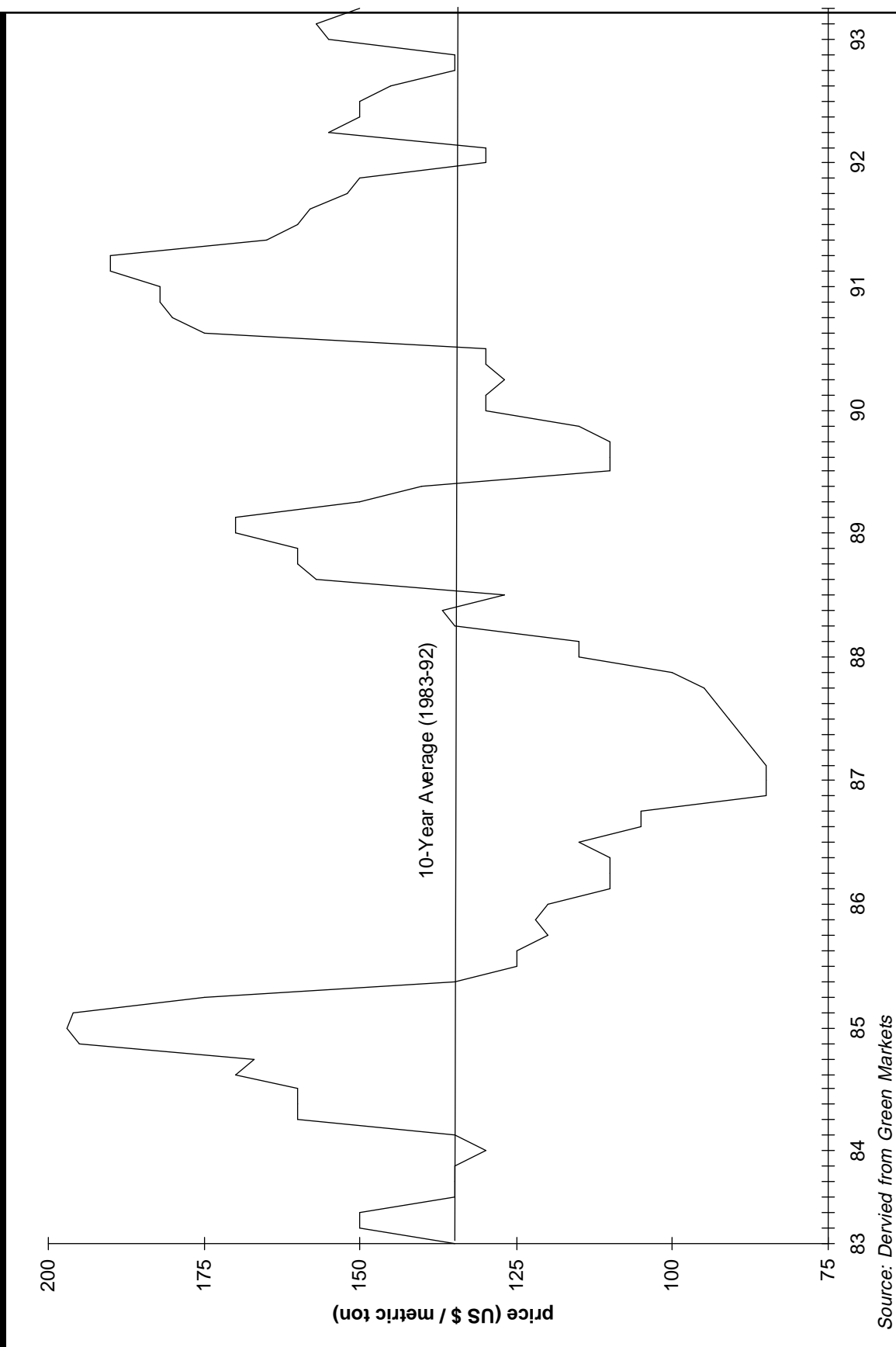


Figure 5.4. Africa: Ten Largest Nitrogen Producing Countries 1991-1992

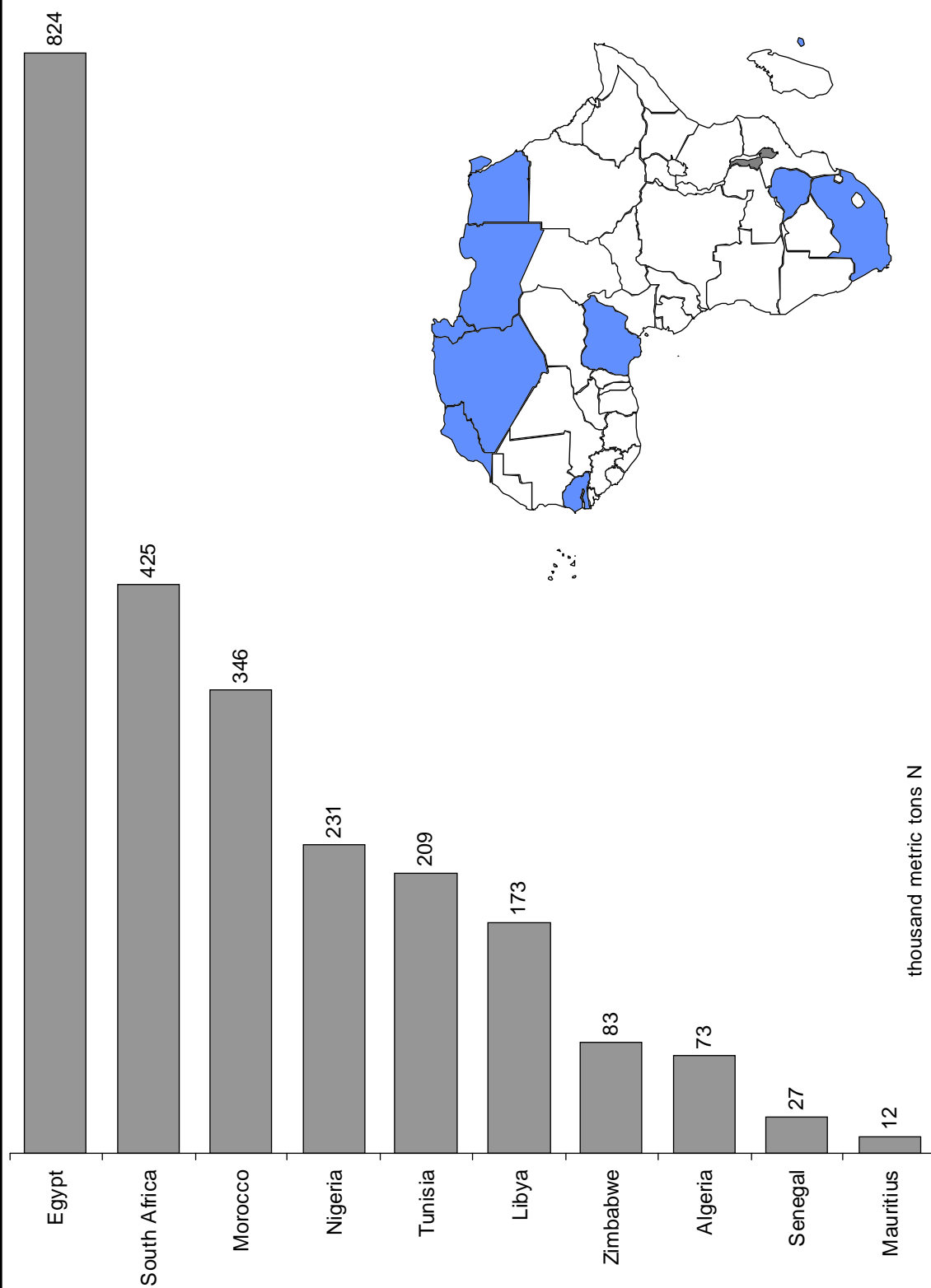


Figure 5.5. Africa: Ten Largest Phosphate Producing Countries 1991-1992

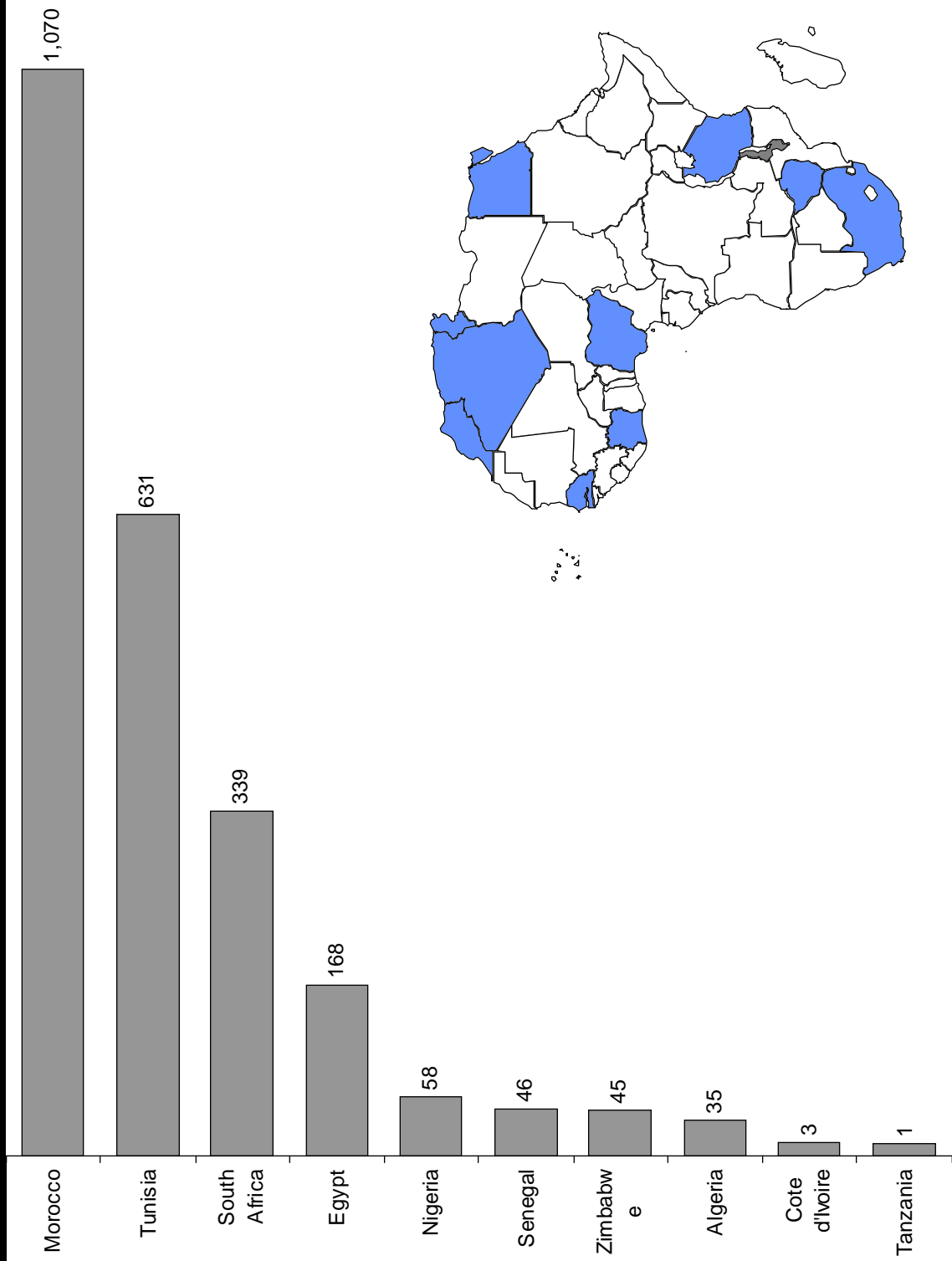


Figure 5.6. Africa: Ten Largest Nitrogen Consuming Countries 1991-1992

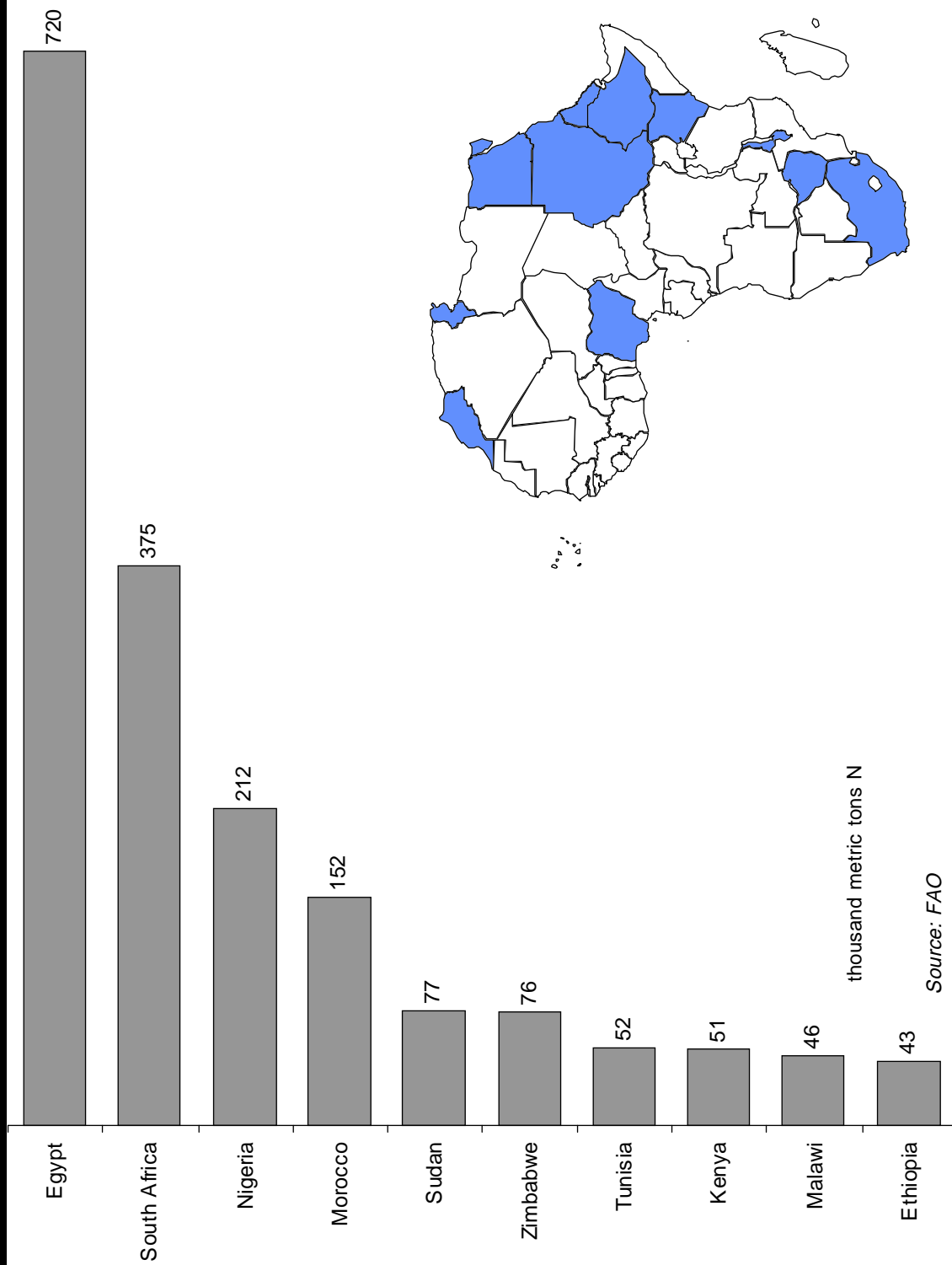
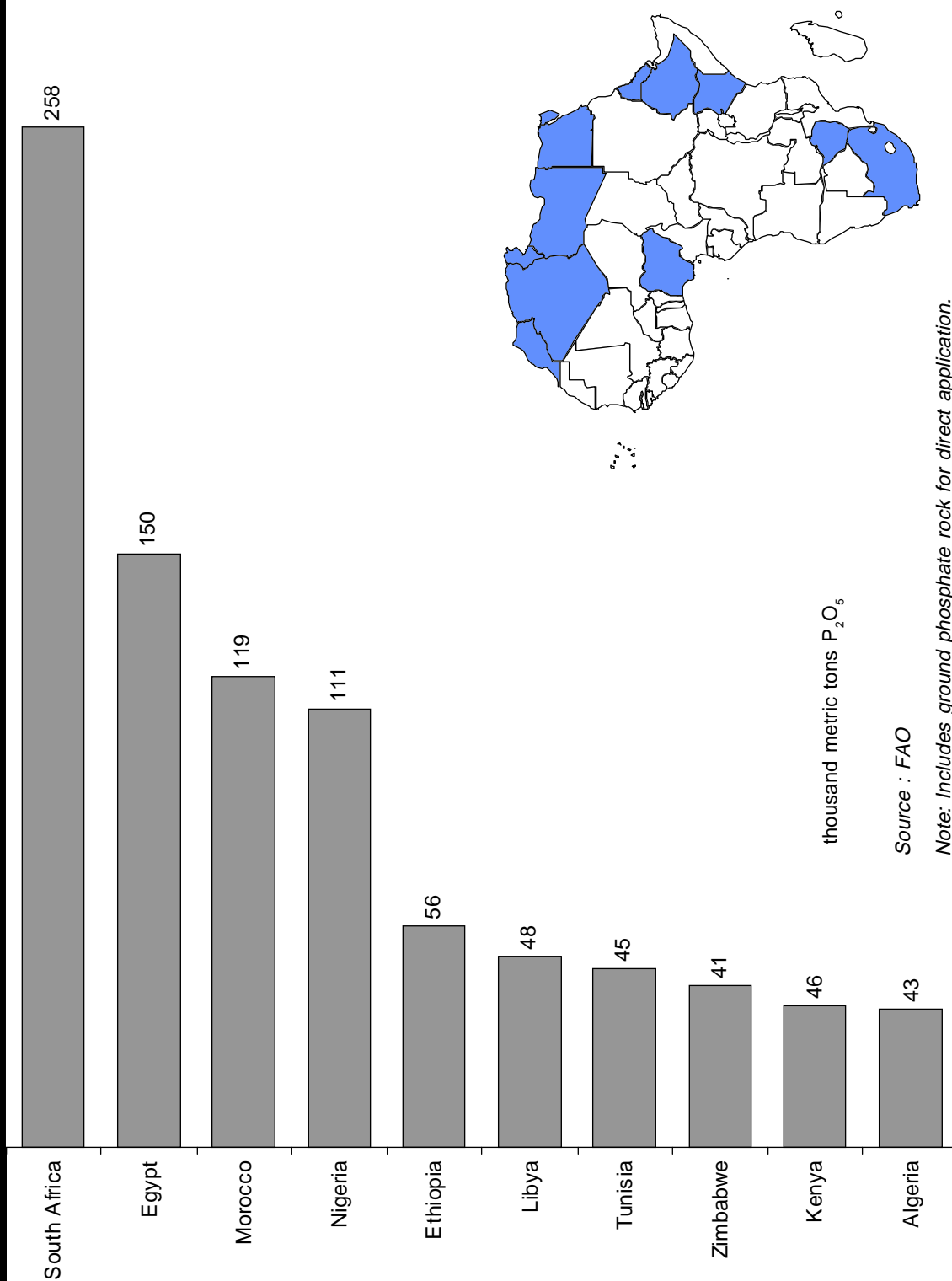


Figure 5.7. Africa: Ten Largest Phosphate Consuming Countries 1991-1992



The challenge is now to progressively improve the availability and accessibility of fertilizers and other inputs to farming communities. Each additional ton of fertilizer that reaches the farmer should boost grain yield by at least ten tons under normal circumstances. However, the results produced by the Zimbabwe Department of Research and Specialist Services (DR & SS) show that under marginal rainfall conditions each additional ton of fertilizer used should boost grain yields by three tons.

The benefits from improvement in availability of and accessibility to fertilizers would be greater if coupled with crop management systems that promote fertilizer use efficiency. Agriculture needs to be profitable. It is well known that decline in soil organic matter leads to soil degradation resulting in weak fertilizer responses thus eroding profitability. Hence, every effort should be made to increase fertilizer use, because it does not only lead to higher grain production and profitability, but also helps higher biomass productivity and hence the building up of soil organic matter which improves nutrient and water use efficiency. This underlines the importance of holistic approaches involving improved nutrient availability and accessibility, adoption of farming systems that emphasize the building of soil organic matter content, and plant breeding for stress environments.

CONCLUSIONS AND OUTLOOK

Sustainable food security can be achieved easily in Africa, given political stability. A great deal can be achieved by addressing constraints all along the crop production line including, fertilizer resource evaluation, fertilizer production, procurement, marketing, distribution, and use. Holistic approaches involving efficient nutrient supply, adoption of farming systems that emphasize building of soil organic matter, and

plant breeding for stress environments require special attention.

In spite of its importance, agriculture is never given its commensurate share of the national budget and investment. The constituency of politicians and policymakers to support agriculture needs to be built to constitute a most powerful lobby group. Unless new policies and programs for technology transfer are implemented to accelerate grain production through efficient and environmentally sound fertilizer use, Africa will face worse hunger, malnutrition, imports of food, indebtedness, internal strife, and environmental degradation.

For food security to be achieved regional plans should shift to emphasize further diversification of the agricultural resource base by introducing higher value crops for improvement of cash incomes and agro-industrial growth. Countries in Asia have achieved this level of development.

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Alternatives to Chemical Fertilizer and Pesticide Uses for Agricultural Production in Africa
by Abou Thiam, Africa Regional Coordinator, Pesticide Action Network (PAN), Senegal

Abstract

Africa is the only continent where the use of chemical fertilizers and pesticides per hectare is the lowest. Despite this fact, there is often a misuse of these agricultural inputs leading to serious accidents which are sometimes lethal.

Following the structural adjustments programs being implemented by many countries in sub-Saharan Africa, a large majority of resource poor farmers are eligible to have access to modern agricultural production technologies, notably chemical fertilizers and pesticides which pose environmental problems. However, in the absence of government subsidies, the price of these inputs in some countries is beyond the reach of the resource-poor farmers. This has become a dilemma for the governments of most sub-Saharan African countries.

The use of nonchemical, low cost, and economically sound alternatives is a more realistic and relevant approach to improve agricultural production in most parts of sub-Saharan Africa. Proper soil and water management, soil texture improvement through the use of organic matter, and crop rotation constitute the basics for sustainable agricultural production.

With the support of NGOs, localized actions such as composting, the use of green manure crops and natural nonchemical pesticides, alley cropping and crop rotations have been practiced by farmers, albeit not on a systematic and continuous basis.

Promising results have been obtained through research on alternative uses of chemical fertilizers and pesticides, but dissemination and adoption of these technologies has been minimal. Extension services have been and still are weak to disseminate the technological packages to different agro-ecological zones on a large scale.

The benefits of alternative technologies to chemical fertilizers and pesticides are well documented. However, their development and dissemination are weak and require the political, economic, and technical support by the respective governments. Such support should be based on the socio-economic and cultural realities of African farmers and their production systems.

Theme IV Summary of Discussions

Chair: Maria Mullei, Program Specialist, USAID/Kenya

Rapporteur: Kwesi Atta-Krah, Network Coordinator, ICRAF, Nairobi, Kenya

Moderators: W. Alhassan, Director General, Council for Scientific and Industrial Research (CSIR), Ghana; Eloise Carter, Associate Director, International Programs, Tuskegee University, Alabama, USA; Roy Shaw, Consultant, Oregon, USA; Emmanuel Atayi, Coordinator of Eco-regional Programs, IITA, Nigeria; Joseph Fajemisin, Research Liaison Scientist, IITA, Bouake, Côte d'Ivoire; J. Norman, Deputy Director General, CSIR, Ghana

Reporter: Kimsey Savadogo, Professor of Economics, SAFGRAD, Burkina Faso

To accelerate the transfer and commercialization of agricultural technologies, improvements in the accessibility, and utilization of inputs are essential.

Two African seed companies have been relatively successful in meeting customer needs. The Kenyan Seed Company was a government-controlled monopoly for 30 years, providing consistent service to Kenya and neighboring countries. The company is now a private firm, competing with national and international seed companies. The Zimbabwe Seed Company started as a cooperative and is now a corporation with shares bought and sold in public auction. Major concerns in both companies are the need to develop varieties for marginal areas and the apparent duplication between the private companies and public research institutions. A majority of African countries lack similar seed companies.

The removal of subsidies under adjustment has led to a decrease in input use, in particular, fertilizers. In some countries, government has phased out input distribution, and the private sector has not filled the vacuum.

Transport and equipment for processing and storage are major areas of concern. Why have so many post-harvest technologies not been used? Perhaps the problem is the inadequacy of analyses done by researchers. Technology transfer would be facilitated by the involvement of end-users in technology devel-

opment, the collection of accurate information on prospective markets, and ongoing attention to the affordability of technologies to target groups. Demand can be generated by creating technologies that add value and give customers choices.

The high cost of capital and the limitations of infrastructure are major constraints. Post-harvest technologies have long lead times and require assistance from manufacturers who are willing and able to commercialize.

African soils require fertilizer to replenish nutrients and optimize production. Constraints include high fertilizer costs, lack of access, and environmental and health problems. There should be increased promotion and support for the use of organic sources of fertilizer and for its combination with inorganic fertilizers.

The existence of a market for the end-product (the one produced using the input) is key to a sustained adoption of inputs by farmers. Cash crops benefit from a coordinated promotion system (availability of credit, guaranteed output market, stable prices, an effective extension system). No similar support is provided to facilitate the use of inputs in food crops.

The removal of subsidies under adjustment has led to a decrease in input use, in particular, fertilizers. In some countries, government has phased out input distribution, and the private sector has not filled the vacuum.

Access to inputs by small-scale farmers is a special problem because of lack of training, information, and credit. Recently, Zimbabwe initiated training to encourage farmers to see the benefits of fertilizer use.

RECOMMENDATIONS

- As part of creating an enabling environment for technology transfer and commercialization, governments should facilitate the involvement of the private sector in the establishment of seed systems and in the processing of food crops, with emphasis on traditional food grains and roots and tubers. Governments may need to protect emerging new industries from unfair foreign competition.
- Governments should strengthen regulatory agencies to ensure quality control of inputs. In particular, governments should promote regional harmonization of seed, pesticide, and fertilizer laws.
- National research systems should work with manufacturers to create appropriate post-harvest technologies and monitor their adoption. This work should include increased attention to the small-scale, informal processing sector.
- National research systems should collaborate with private companies to maximize research efforts and avoid duplication of activities. One area for collaboration is market studies to gain a better understanding of national and regional markets for products and inputs.
- Governments should make long-term investments to maintain soil fertility and rebuild the natural resource base. Without these investments, the long-term sustainability of the natural resource base will be threatened.
- Governments, in collaboration with donors, should invest in increasing business and entrepreneurial skills in rural areas to help small business development in input production and distribution. For example, research and extension systems, working through nongovernmental organizations and community-based programs, could provide technical support to enable farmers to multiply seed.

6. Plenary Session V

Theme V: Innovative Partnership Development

Topic I: Partnership Initiatives for Improved Coordination in Technology Transfer and Commercialization

Chair: Nathaniel K. Tum, Managing Director, Kenya Seed Company, Kenya
Rapporteur: Charles Whyte, Agribusiness Advisor, USAID/AFR/SD/PSGE/PSD

Developing Partnership Initiatives for Agricultural Transformation in Africa: Challenges and Opportunities by Johnson Nkuuhe, Member of Parliament, Uganda

Abstract

Funding for agricultural research in Africa, which has in the past depended on donor funding supplemented with token government support, is now facing a crisis. In 1995, the 47 countries of sub-Saharan Africa (SSA) attracted a mere three percent of the flow of foreign direct investment into the developing world compared with 60 percent in East Asia and the Pacific. With the end of the Cold War, funding for development and research in Africa has tended to dry up, and the trend will only worsen in the future. The countries of Africa spend much less than the recommended two percent of their gross domestic product (GDP) on agricultural research. In fact, most spend less than 0.5 percent. Since GDP in these countries is low in real terms, the actual sums spent on agricultural research are too little to support meaningful research programs.

CHALLENGES

Most agricultural research in Africa is donor driven with all the negative implications that this entails. Donor dependence must reduce as donor funds are declining.

In 1995, only four developed countries met or exceeded the expected target of donating 0.7 percent of their GDP as aid. The United Nations (UN) General Assembly noted in resolution 49/93 that net transfer of resources from the Bretton Woods Institutions

to developing countries has been negative in real terms. The problem with donor driven research is that donor agenda and priorities do not always tally with those of recipient countries. Donor demands and priorities keep shifting and tend to emphasize short-term projects whose impact is readily visible. Unfortunately, visibility in this case lies in the eyes of the beholder.

Little funding comes from local sources, whether public or private. The little that comes from local sources, mainly government, comes late and is unstable and unpredictable. There is a need to increase funding from local sources. Over the last three years, funds budgeted and approved for the National Agricultural Research Organization (NARO) of Uganda have been on the increase representing 30 percent of NARO's needs; the rest is met from donor funds. To attract funding from local public and private sources, African research managers need to establish mutual partnerships with stakeholders, i.e., governments, farmers, processors, and exporters. The managers need to know the need and priorities of each of these stakeholders and to design research that is client-oriented and demand driven. NARO is moving in this direction by having client linkages through researcher-extension-client participation in priority setting, program planning, technology transfer, and on-farm research. Clients are also represented on the NARO Board, the highest policy body of NARO.

Most stakeholders of agricultural research do not think that the research is relevant to their needs and will therefore not be willing to finance it, at least in the short term. Researchers need to generate funds from their own sources to sustain their activities. Traditional researchers have tended to pursue academic excellence when conducting agricultural research. There is a need to re-orient the thinking of the research scientists and the research managers. Attitudes need to change, scientists need to operate in a businesslike manner. There is need for open discussion and accountability to avoid waste and conflict of interest since commerce will coexist with science.

For a system to be sustainable, the stakeholders need to have confidence that the system serves their best interests. Once these confidence bridges are built, then the level of funding will be adequate, timely, and stable.

OPPORTUNITIES

The challenges of diminishing, untimely, and unpredictable financing of research need an appropriate response. The overall response should be for NARSs to reduce dependence on donor and government funding by creating internal self-sustaining systems for funding, conducting, and disseminating agricultural research and technologies.

Agriculture is vital to the economies of most African countries. Most governments in SSA derive over 60 percent of their gross domestic product (GDP) from agriculture and about 80 percent of the populations derive their livelihood from agriculture. The challenge is for research managers to remind the politicians that research is vital to agriculture.

Democracy and liberalization have empowered beneficiaries of research. The wind of change that is sweeping Africa now, as a result of democratization and liberalization, has the potential of giving a powerful voice to farmers and rural people in Africa. Funds are being decentralized, and they actually reach rural areas. Decisions are made locally. The challenge is for researchers to build partnerships with farmers at the grassroots level so that they can pres-

sure governments and donors to fund rural-based agriculture and natural resources management. Such research efforts are sustainable and will attract donor funding.

Although donor funds have decreased, they are still available with more focus on programs to save the environment and to empower women. There are opportunities for NARSs to take advantage of these programs.

Collaboration attracts and utilizes resources more economically. Such collaboration can be national, regional, or at the international level. NARO collaborates with all three and could still do more and attract funding for research.

Newer sources of funds for NARSs include endowments and trust funds, cess or checkoff, levies and user fees. They involve negotiation usually between an African government and a foreign government or organization. While little funding has come from this source, it is a potential source of some funding, albeit on a small scale. NARSs need to articulate their needs to their host governments to be beneficiaries of such sources. In Uganda, NARO's coffee research institute is partly funded by cess from coffee exports.

Commercialization opportunities exist within the NARSs. The best example is the sustainable funding initiative project in NARO. This is a project initiated in 1995 aimed at looking for alternative sources of funding to supplement government and donor financing of NARO research programs. The project was started in collaboration with Special Program for African Agricultural Research (SPAAR). Following a consultant's recommendation, eight areas were identified for sustainable funding initiatives and a commercial directorate was set up to spearhead commercial operations. NARO is also exploring endowment and trust funds, cess, checkoffs, and debt swaps.

Funding for agricultural research is facing a crisis, but this challenge presents opportunities which, with a bit of imagination and paying attention to stakeholders, should lead to ways of additional funds to supplement traditional sources of financing for NARO and other national agricultural systems.

Public Research Institution and Private Sector Collaboration in Facilitating Local Business Development: The Aquaculture Experience in Rural Maryland by William P. Hytche,
President, University of Maryland Eastern Shore, USA

Abstract

The University of Maryland Eastern Shore (UMES) collaborated with a group of local entrepreneurs with business interest in aquaculture, to develop a prototype aquaculture system for commercial use. The unique feature of the partnership was that research and development (R&D) activities were based on a market-driven, consumer-focussed philosophy. A group of entrepreneurs conducted a market study that established the potential demand for fish production through aquaculture. The entrepreneurs then approached UMES, to utilize its research capability, laboratory, and scientists to conduct R&D, to develop a prototype aquaculture system for raising Talapia. UMES then entered into a cooperative agreement with the local entrepreneurs under the following conditions:

- the university provided researchers' time for the R&D;
- the entrepreneurs provided funds to support a graduate research assistant who worked on the project;
- the management decisions on R&D activities were controlled by the entrepreneurs and not the researchers, which substantially limited desire by

the researchers to focus on research for publication, therefore, the project had a business focus; and

- each partner had the right to call for discontinuation of the project if it was found not to be beneficial or accomplishing the objectives of a partner.

Through this arrangement, the local firm had access to expensive research facilities at the university at no up-front cost for research infrastructure, which the firm would not have been able to afford and hence not ventured into R&D. The university scientists found a novel approach for fulfilling their public service duties to the university's community.

After two years of R&D, a prototype aquaculture system acceptable to the entrepreneurs was developed. The entrepreneurs formed a commercial aquaculture business called AQUAMAR with the system developed at UMES. The university now provides laboratory research for them at cost. AQUAMAR's volume of business has increased by 500 percent over a five-year period. The local company now competes in the international Talapia market.

***Financing Agricultural Research In West Africa Through Endowments: Establishing Agricultural Research Foundations** by Sanath K. Reddy, Assistant Director, Productive Sectors Development Office, Regional Economic Development Services Organization, West and Central Africa (REDSO/WCA), USAID, Abidjan, Côte d'Ivoire*

NEED FOR SUSTAINABLE FUNDING MECHANISMS

For nearly twenty years, donors, especially USAID, have been providing substantial resources for agricultural research in West and Central Africa (WCA), notably in Mali, Burkina Faso, Senegal, The Gambia, Niger, Cameroon, and Zaire. Somewhat fewer resources were provided to countries such as Guinea, Mauritania, and Cape Verde. At the National Agricultural Research Systems (NARSs) level, USAID investments included direct support to various NARSs through bilateral projects and Collaborative Research Support Projects (CRSPs). In addition, USAID has also funded major long-term regional research efforts through projects such as SAFGRAD I and SAFGRAD II, IPM, AGHRYMET, Senegal River Basin Development Programs and West African Regional Research Networks (maize, sorghum, cowpeas, and rice). Some of the bilateral programs, CRSPs and regional research networks are continuing at present. Resources under these programs were provided in the form of institutional development, support, technical assistance, graduate level training, equipment, infrastructure development and operating costs. In addition, USAID support and participation in multi-donor effort through the CGIAR centers in Africa (IITA, ICRISAT, WARDA, ILRI, ICRAF, IFDC) provided valuable assistance to NARSs in the form of collaborative research, training, equipment, germ plasm exchange, and certain operating costs. Other donor support to the NARSs, especially the French support, has also been substantial.

During this period, NARSs have generally provided research personnel, physical plant (offices, laboratories, and research stations), limited equipment,

and operating costs from national budgets. It has been variously reported that about 90 percent of national support goes for staff salaries and allowances leaving very little for operating and other research costs, resulting in heavy dependence on external support for agricultural research and development. Also, during this period donor collaboration and support to the NARSs has resulted in substantial strengthening of the NARSs in terms of qualified staff; improved capacity for research management, planning and critical assessment of research priorities and needs, focus on research impact and technology transfer; and increased regional collaboration to address cross cutting problems and to exploit national comparative advantages. However, a major continuing constraint at the NARSs level is the lack of funding to meet the ever increasing operating costs of research to maintain the research momentum. Dependence on donor and external support continues to be a major factor in keeping the NARSs operating at the level required to meet their obligations. National budgetary support for operating costs has remained stagnant and even fell below the past levels in several countries. The dangers of this situation are clear. African pessimism, donor fatigue, and reduced levels of foreign aid will directly and adversely affect the funding for agricultural research among traditional donors.

If dependence on donor funding is to be reduced, innovative ways of funding agricultural research to sustain the volume and level of research must be identified and implemented as a matter of priority. This brings us to the concept of sustainable funding mechanisms. It is in this context that the concept of a National Agricultural Research Foundation is proposed and broad outlines of a model set up are presented in this paper.

NATIONAL VS. REGIONAL FOUNDATION

After a careful examination of pros and cons, setting up a National Agricultural Research Foundation (NARF) appears to be feasible, practical and will pose less operational problems.

A regional foundation will pose legal jurisdictional problems as well as management and operational problems. The level of national contributions and reallocation of resources to the national and/or regional R&D and its coordination will create another problem. A national foundation, on the other hand, will be far simpler to establish, manage, and operate.

NARF: ESTABLISHMENT, STRUCTURE, OPERATION, AND RESOURCES

Establishing the Foundation

Two possible scenarios are as a parastatal institution and as a nongovernmental organization (NGO):

- As a parastatal institution, the government will issue a decree establishing a NARF as a quasi-governmental/parastatal institution to be operated as an autonomous non-profit, public interest foundation accountable to the national legislature or to an institution designated by the legislature. The decree establishing the foundation will be based on a charter and by-laws and internal regulations, which describe the purpose, structure, and functions of the foundation.
- As a nongovernmental organization, the foundation will be established under the existing laws of the country.

The NARF will be established at the national level (e.g., Ghana Agricultural Research Foundation or Mali Agricultural Research Foundation, etc.). It will be an autonomous body established under the laws of the country. Some countries in WCA may not have laws which provide precedence for the estab-

lishment of such foundations as either state sponsored or parastatal institutions. Therefore, a special decree may need to be issued by the government. Alternately, the foundation could be established and registered as a local NGO under the existing laws.

Initiating the Action

Initially the Director of the NARS, with the concurrence of the Ministry of Agriculture (MOA) will constitute a “Consultative Committee” representing institutions which will be ultimately represented on the board of directors of the foundation. There could be three to four members representing each set of interests. At this stage the net should be wide enough to draw in as many supporters of the idea as possible. Several sessions, formal and informal, will be required to get everybody on board and get a common understanding of the process and product.

The Consultative Committee (CC) will determine under which option the foundation should be established and accordingly prepare the charter and by-laws of the NARF. Once the NARF Charter is ready, the MOA will approach the government to issue a decree establishing the foundation. Once the decree is issued, the Executive Vice-President will take all necessary steps to operationalize the NARF, and the CC will continue to serve as advisory body inducting new members as needed.

Structure

The NARF will be governed by a board of directors. The principles that govern the size and choice of what the membership mix should be that members:

- have the ability to attract and maintain government, public support, and donor support at least in the formative years;
- protect/safeguard public and donor resources and interests;
- have personal and professional integrity;
- represent farmer interests;
- represent commercial interests;
- represent financial management institutions (banks, insurance, companies, internet);

- manage the size of the board of directors membership; and
- be research and extension system representatives.

Suggested Membership

The board of directors will consist of seven voting members representing the following: Minister for Agriculture (President); senior-most civil servant of the Ministry of Finance or the central bank of the country (Vice President/Treasurer); Director, NARS (Executive Vice-President); representative of a commercial bank (to be nominated by Bankers Association); representative of an insurance company; representative of farmers; representatives of input suppliers or food processors; donor representative (non-voting); and an Executive Secretary (non-voting).

Constituting the Board of Directors

This would largely depend on the option selected to establish a foundation. Under the first option, the government will nominate a part of the board and request associations of interested

groups to nominate their representatives to the board. Under the second option the board of directors will be elected by the members of the NGOs. Under this option the issue of protecting and securing public interest must be addressed.

Operation of the Foundation

The foundation will operate under the charter. The charter will describe in detail the following elements:

- legal basis and principal features;
- purpose/objectives of the foundation;
- organs of the foundation (boards of directors: its composition, selection, functions; officers of the board, role, functions, etc.; management (Executive Vice-President, Executive Secretary) role and functions);

- endowment (mobilization of resources: processes, conditions, criteria; investment and financial management of endowment funds; allocation of resources; audits, accountability); and

- internal regulations and operating procedures.

Secretariat/Administrative Offices of the Foundation

The Directorate of Agricultural Research Systems (NARSs) will provide the foundation (NARF) with office space and secretarial support. This support will be modest and minimal so as not to create an office structure with heavy overhead costs, absorbing limited resources. The foundation's day-to-day operations will be vested in the Executive Secretary working under the direction of the President of the Board and the Executive Vice-President.

The NARSs will provide a qualified person (preferably a researcher) and a secretary to manage the operations of the NARF. Initially, it will require an office space of 2-3 rooms, a telephone, a

computer, a typewriter and operating costs for telephone and stationery. The two-member staff should be drawn from the existing personnel of the NARSs. The foundation should have its own postal address.

Critical Role of NARSs

The role of the director of national agricultural research is very critical in the initial stages of the establishment of NARF, since it is the primary and immediate beneficiary of the NARF; it has close contacts/links with key national Ministries, donors and the farming community. The director of a NARS plays a critical pro-active role and takes the lead. Identifying individuals to serve on the consultative committee and coopting various donors who will be committed will be a key task.

Establishing a NARF is a complex task. It takes intensive effort, a core group of committed individuals, public and human relation skills. It takes time,

The success of the NARF will depend on the extent to which it can successfully generate contributions, establish, manage and operate an Endowment Fund whose annual earnings will be used for supporting national agricultural research efforts.

patience and willingness to sacrifice/postpone the use of a certain level of resources for future benefits.

Resources: Endowment Fund — Key to Financial Sustainability

The success of the NARF will depend on the extent to which it can successfully generate contributions, establish, manage and operate an Endowment Fund whose annual earnings will be used for supporting national agricultural research efforts.

The endowment contributions (from national budget; donors and others) will be invested in safe income generating financial instruments (fixed deposits in commercial banks, national treasury bonds, etc). Investment decisions should be made on a commercial basis, by the entity (a commercial bank) managing the endowment fund. Ideally the deposits will be held in offshore foreign accounts (in US dollars and one major European currency) and in an in-country account (in local currency). The aim should be to maximize interest rate earnings and protect against inflation/devaluation and loss of value.

Annual interest only from the endowment fund will be available to the board of directors for allocation to agricultural research (including livestock research). The NARF operating procedures should prescribe the maximum percentage of net endowment income (about five to eight percent) that should be spent on administrative costs of the NARF, the rest going to fund annual operating costs of research.

Allocation considerations: The NARF board of directors should allocate funds to major research interests, based on national priorities (rice, maize, meat, poultry, etc.) and specific requests submitted by research units. The board of directors should leave the details to research units. The funds allocated by the NARF board of directors will supplement the national budgetary resources and thus should become an integral part of a NARS's budget. They should be accounted for by the research system in the same fashion as for the funds provided by the national budget.

Source of Endowment Funds

The target amount is \$8.5 million for a period of five years. An endowment fund of \$10 million collected and invested over a five year period (average eight percent p.a.) would generate about \$450,000 annually in interest earnings by the end of the fifth year (Table 1). These earnings will be available annually, beginning in the sixth year, to fund agricultural research in the country.

The following sources should be sought and canvassed for contribution to the fund: national budgetary contributions; donor contributions (project funds and special one time fund); overseas foundations (CIBA-GEIGY, Ford, etc.); contributions from agricultural businesses, exporters (cotton, meat); contributions from farmers' groups/associations; contributions from local suppliers of agricultural inputs; and other sources.

National Budgetary Contributions

Governments should contribute an amount of \$1 million per year to the foundation, either earmarking a portion of the NARS's budget or making a special allocation in the national budget. These special allocations could come from the agricultural sector loans often secured by the national governments. With several governments receiving World Bank (IDA) and African Development Bank (AFDB) loans for agricultural sector strengthening and national agricultural research, such a contribution should be less problematic given the national will and conviction that the agricultural sector is at the center of economic growth.

Donor Contributions

Donor projects supporting agricultural research should allocate a portion of their annual support as contribution to the NARF endowment fund. Such allocation is feasible and should form the subject of host country and donor negotiations. In addition, special one-time grants from donors should be sought. Special consideration should be given to exploring commodity grants and their monetization (fertilizers and equipment) and US Food For Development grants to provide donor contributions.

Table 6.1. Illustrative - Model Endowment Budget - National Agricultural Research Foundation (NARF)

Source	Year 1	Year 2	Year 3	Year 4	Year 5	Total
1. National Budget	300,000	1,000,000	1,000,000	800,000	800,000	3,900,00
2. Donors	300,000	1,000,000	1,000,000	800,000	800,000	3,900,00
3. Food Processors	50,000	50,000	50,000	50,000	50,000	250,000
4. Agribusiness/Exporters	30,000	30,000	40,000	50,000	50,000	200,000
5. Farmers Producers Associations	20,000	30,000	30,000	50,000	50,000	180,000
6. Total current year contributions	700,000	2,110,000	2,120,000	1,750,000	1,750,000	8,430,000
7. Interest on (6)*	28,000	84,400	84,800	70,000	70,000	337,200
8. Funds at beginning of year**	0	691,600	2,774,262	4,915,953	6,742,768	
9. Interest on funds***	0	55,328	221,941	393,276	539,421	
10. Total	728,000	2,941,328	5,201,003	7,129,229	9,102,189	
11. Expenses						
(a) Administrative	0	(20,000)	(25,000)	(30,000)	(35,000)	(110,000)
(b) Bank Fees 2% of 10	(14,560)	(58,827)	(104,020)	(142,585)	(182,044)	(502,035)
(c) Capital Maintenance 3% of 10	(21,840)	(88,240)	(156,030)	(213,877)	(273,066)	(753,052)
(d) Total Expenditures	(36,400)	(167,066)	(285,050)	(386,461)	(490,109)	(1,365,087)
12. Total End of Year	691,600	2,774,262	4,915,953	6,742,768	8,612,080	
* Interest on Current year contribution calculated only for 6 months at 8% P.A.						
** Item 12 of previous year.						
*** Interest on "funds at the beginning of year" calculate for 12 months at 8% per year. Placement of funds assumed...overseas US & Europe at 8% average (medium, long-term deposits). With placement of a portion of funds in local banks (fixed deposits; treasury bonds, etc.) - coming from sources 1, 3, 4, 5 average interest rate could be higher.						

Philanthropic Foundations

Foundations such as CIBA-GEIGY (Swiss), Ford and Rockefeller (USA) have traditionally supported agricultural research in least developed countries (LDCs). Special effort should be made to seek their support through special grants spread over three to five year periods.

Special Annual Contributions

Special annual contributions from the groups identified above should be solicited. Exporters of commodities such as cotton, peanuts, meat, coffee, cocoa, etc. should be preferentially lobbied for annual contributions. As beneficiaries of agricultural research technologies, they should be willing to contribute.

The solicitation process and strategy should include:

- in-country fund raising/pledging meetings;
- annual meetings of donors and multilateral institutions, e.g., Club du Sahel, World Bank and AFDB meetings, CGIAR Centers Week, West African agricultural ministers annual meetings, etc.; and
- special presentations to foundations, private organizations (PVOs) and multinationals in USA, Europe, Canada and Japan.

***Comparative Advantages of the Public and Private Sectors in Facilitating Partnership
Initiatives to Support Rural Development*** by Peter Katjavivi, Vice Chancellor,
University of Namibia, Windhoek, Namibia

Abstract

Success in Africa's agricultural development depends on availability, acquisition, utilization, and successful transfer of appropriate technology. The process of technology transfer is a chain of communication systems involving a series of links and couplings that start with experimental testing, continue through validation in agro-ecological zones and finally reach out to the farmers.

Three considerations in technology transfer are the physical technology to be transferred, the skills needed to apply the technology (the necessary human resources) and the local organization to deal with the newly introduced technology, including farmers' participation.

PROBLEMS OF TECHNOLOGY TRANSFER

- Technology can only lead to human development if it has been transferred.
- Technology is said to have been transferred successfully only if wide scale adoption by farmers is evident.
- Farmers will adopt a new technology widely if it is both relevant and appropriate.
- For a technology to be appropriate for farmers, it must be relevant to their needs appropriate to the households' resources and operating circumstances.
- For farmers to adopt and use a new technology on a wide scale, there must be a good match between the technology and the farmers' needs and resources.
- To design a truly effective and appropriate technology, the field researcher must be in the field with the local people, to learn from the farmers.
- Reaching rural people requires appropriate means of transportation.
- For technology to be acceptable to the farmers, it must be biologically sound, socially acceptable, economically feasible, and environment-friendly.
- Farmers have often rejected new technologies where there is a disharmony with cultural practices, their social way of living and the environment they live in.
- For promoting sustainable agricultural and rural development, the most efficient and feasible combination of human and natural resources as well as social and cultural factors must be considered.
- Effective and efficient technology transfer requires strong networking of research institutes, experimental stations, extension services, input suppliers, and credit organizations.
- In many African countries, research and extension services have had limited impact in the rural areas due to the lack of suitability of the technology to the local environment and extension resources promoting expensive, unaffordable fertilizers, pesticides, and mechanization.
- In most of Africa, women represent the bulk of rural farmers, yet less than ten percent of all agricultural extension officers are women, thus the main players of rural agriculture have remained forgotten for a long time.

THE CASE OF NAMIBIA

According to the 1994 estimates, 68 percent of Namibia's 1.5 million people derive part of their livelihood from agriculture and forest resources, but the agricultural sector in the rural areas is underdeveloped. Crop and livestock production are low and marketing infrastructure is poorly developed.

Prior to independence, most of the extension services were directed to Namibia's 4,000 white farmers. The commercial farming sector was well funded and also provided with qualified extension staff. After independence, the government established a directorate of agricultural development in the newly established Ministry of Agriculture, Water, and Rural Development. A new rural extension services division was also established which is serving a vital role of reaching out to the rural farmers. A new Faculty of Agriculture and Natural Resources has been established at the University of Namibia whose mission is

to provide education and training aimed at producing degree level graduates. The skills of such graduates should help to improve agricultural production and productivity, increase Namibia's food security and provide advisory, consultancy, and extension services to both communal and commercial farmers.

The government, with assistance from ISNAR, has prepared a five-year Namibia agricultural research plan as well as extension strategies that will facilitate efficient technology transfer for both groups of farmers. Currently, the government is developing a national land policy that will improve access to agricultural resources and services, including credit to communal farmers.

Gender awareness is also being promoted. A new gender research unit has been established at the University of Namibia's Multi-disciplinary Research Center and will work closely with the Department of Women's Affairs' Office of the President.

Improvements in Potato Storage in Burkina Faso by Roy Shaw, Potato Storage Consultant, Ashland, Oregon, USA and Rudy Vigil, TDT Unit Leader, USAID/AFR/SD/PSGE

Abstract

Potatoes in the Sahel region have become an important component of the diet of rural as well as urban residents and a source of export earnings. Sahelian-grown potatoes have taken over the markets formerly occupied by imported potatoes and have displaced, to a large extent, the potatoes imported to the region from Europe.

Irregularities of potato prices in the Ouagadougou market and consultations with communal farmer groups helped identify storage of seed potato as a high priority. The types of storage being used in Burkina Faso were not suitable for the hot, dry conditions of the Sahel. Work was initiated with two farmer groups, the Farmers' Association (Groupements NAAM), which is active in 1,200 villages in Burkina Faso and the Vegetable Cooperative of the Upper Sourou Valley, which has over 350 families as members. These two cooperatives produce over 80 percent of the potatoes in Burkina Faso. A decision was made by the farmers to follow the lead of potato growers in the Andes of South America and construct a potato storage building out of adobe brick, the common domestic building material in Burkina Faso. With the help of the USAID technical advisors, Groupements' farmers designed storage structures. Twenty villages contributed bricks, labor, and other local material to the construction effort. Groupements NAAM provided material that had to be purchased on the market.

The farmers identified another need. They requested that a training course on potato production and storage be given to their farm leaders and field technicians. Training covering potato production, storage, dehydration, seed stock, and diseases was held at Groupements NAAM's headquarters. Two courses were given, each for a four-day session. Women represented 35 to 50 percent of the students in the respective courses. Training was conducted in the farmers' fields and in the classroom.

The storage life of potatoes at the farmer level was increased by four to six months through the construction of farmer designed storage structures and by training lead farmers and technicians on potato storage techniques and production technologies. The program worked with organized farmer groups which allowed farm leaders and technicians to extend potato storage technology to other growers.

The key to the success of this program was the strong partnerships that were formed during the implementation of the program among the two farmer groups, the National Solar Energy Research Institute, the National Agricultural Research Institute, the local artisan group, the U.S. technical advisors and their organizations, and United States Agency for International Development (USAID).

Topic II: Domestic Capacity Building for Sustainable Agricultural Technology Transfer and Commercialization

Institutional Innovations in Integrated Pest Management (IPM) Technology Transfer and Adoption: Farmers' Field School (FFS) in Ghana by K. Afreh-Nuamah, University of Ghana, Legon ARS-Kade; S. M'Bood, FAO Regional Office for Africa, Accra, Ghana; S. Korang-Amokoh, Department of Agriculture Extension Services, Ministry of Food and Agriculture (MOFA), Ghana; G.A. Dixon, Plant Protection and Regulatory Services Department, MOFA, Ghana; J.A. Poku, Department of Crops Services, MOFA, Ghana; E.O. Poku-Mensah, Ghana Irrigation Development Authority, MOFA, Ghana; and C.H. Anamoah, Plant Protection and Regulatory Services Department, MOFA, Ghana

INTRODUCTION

A number of environmental and agronomic problems such as weeds, declining soil fertility, diseases, insects, and vertebrate pests are considered major constraints to rice production. Pressure from these constraints tends to promote increased use of pesticides that might create serious environmental problems.

Integrated pest management (IPM) has been recognized as one of the practical alternative measures to deal with the many problems emanating from pesticide use. It advocates the integration of the management of any given pest as well as all appropriate cultural practices into the overall farming systems.

The Food and Agricultural Organization (FAO) intercountry program for IPM for Asia developed a model that uses the participatory approach and emphasizes "farmer empowerment" by developing skills that enable farmers to be better managers and key decision makers on their farms. Based on the success and experience of this model with rice IMP and proposals for funding, the FAO agreed to fund a pilot project for adaptation of the Asian IPM training methodology to West African conditions under a technical cooperation program (TCP).

The pilot, sited at the Dawhenya irrigation project, brought together 28 field extension personnel — 24 of whom came from the various departments of Ghana's Ministry of Food and Agriculture (MOFA), three from Côte d'Ivoire, and one from Burkina Faso — for training under an IPM training consultant from

the FAO intercountry rice IPM in Asia. Two trainers from the Philippines National IPM Program were contracted in 1995 for the training. The West African Rice Development Association (WARDA) provided the technical backstopping.

Integrated pest management (IPM) has been recognized as one of the practical alternative measures to deal with the many problems emanating from pesticide use. It advocates the integration of the management of any given pest as well as all appropriate cultural practices into the overall farming systems.

The Dawhenya experience showed that the farmer field school (FFS) training concept, developed in southeast Asia, could also work in Africa. This observation was endorsed by the participants of a FAO technical consultation on participatory training in IPM for Africa at Akosombo, Ghana, in September 1995. Consequently, follow-up training programs for rice farmers were established at five irrigation sites (Ashaiman, Dawhenya, Afife, Bontanga, and Tono) in Ghana.

The main objective of the IPM follow-up program was to extend the Dawhenya experience to other regions or ecologies so that smallholder farmers would use pesticides rationally to avoid the resur-

gence of certain pests and/or their resistance to chemicals and environmental hazards.

THE IPM FARMERS' FIELD SCHOOLS TRAINING METHODOLOGY

The training programs were preceded by baseline surveys at each of the irrigation sites, where the facilitators interviewed a cross section of farmers to determine the prevailing farming practices at each locality. Some of the important factors documented during the survey include the following:

- socio-cultural, age, sex ratio, language, taboo days, and land holding;
- agronomic practices - main varieties of rice grown, planting method, average yield, and net returns;
- agro-chemical use and other inputs - fertilizer requirements, and types and frequency of pesticides used;
- crop protection problems; and
- general farm problems.

Basis for Farmer Selection

Farmer participants at the field schools were selected according to the following considerations:

- full time farmers working on rice production at the irrigated sites;
- energetic farmers fit to undergo field activities;
- willingness to be available once a week for the entire crop cycle of rice;
- no gender discrimination (male:female ratio to reflect actual situation at the site);
- farmers from contiguous area to foster group/team building and cooperation; and
- sectional representations.

AGRO-ECOSYSTEM ANALYSIS (AESA)

Agro-ecosystem analysis is a tool for empowering trainees in the management of their own rice ecosystems through proper decision making based on critical analysis of actual field situations. Every week, trainees made and recorded field observations, processed and analyzed these observations and made decisions regarding the proper management of the field to be evaluated during the next re-entry in the field.

AESA usually involved:

- observations and data collection on crop growth characteristics (agronomic) and insect/spider number counts (entomological);
- processing of collected data with recommendations;
- presentation of results; and
- implementation of recommendations in the field (including field work).

The following were some steps involved in the collection of the weekly data.

- Step 1: Collection of General Information
- Step 2: Collection of Agronomic Information
- Step 3: Collection of Entomological Information
- Step 4: General Field Observations

In addition, information on the weather, crop performance, level of weekly infestation, water depth, insect pest and natural enemy population ratio, and rodent infestation were observed and discussed.

Special Topics

Technical topics crucial and relevant to the proper understanding of the management of the agro-ecosystem were identified by farmers and facilitators in the field, based on local needs.

Apart from the technical special topics, the training included educational and program management special topics that aimed to elaborate on how to extend the training to other farmers. These special top-

ics included informal education and community organizations.

Group Dynamics

These exercises aimed to strengthen group cohesion among the farmers. These emphasized group processes that play an important role in the implementation of local IPM programs in the field, such as team building, cooperation, problem solving, decision making and leadership. For example, during the process the training facilitators tried not to answer direct questions such as “What is this insect?” with a direct answer like “This is a variegated grasshopper”, but to establish information about the insect by asking a series of question, that focus on the insect and its function in the ecosystem. Questions like “Where did you find it?”, “What was it doing?”, etc. were asked to stimulate the sense of observation of the farmers.

FARMERS’ FIELD SCHOOLS

These IPM training programs were conducted in what is termed IPM farmers’ field schools (FFS). Each field school comprised 25 farmers who agreed to meet at least once a week for about half a day (4-5 hours), during the entire cropping season. These 25 farmers were subdivided into groups of five with a leader. During each FFS day, these subgroups conducted their own observations and a member of each subgroup presented their observations with recommendations to the school.

Training Approach

The whole training curriculum was experiential and discovery-based, aimed at making farmers experts in decision making on their own fields. The method of learning was by “do it yourself.” About fifty percent of the time was spent in the field where farmers worked, observed, and shared ideas together. Presentations and discussions of observations were held under a tree, as in Ashaiman, or under a shed with canopy, as in Tono, Dawhenya, Afife, and Bontanga. Exchange of information and sharing of experiences among farmers were facilitated through discussions within and among small farmers groups. Trainers

were primarily facilitators of learning and only introduced new information when it seemed necessary and appropriate.

Three main areas of learning, namely work, interaction and empowerment, were emphasized in the training program.

The general purpose associated with work included knowledge relevant to making management decisions concerning agronomic and ecological factors that must be made by a farmer practicing IPM strategies. The following guidelines, derived from the Indonesian National IPM Program, were adopted in the implementation of the program: grow a healthy crop; preserve natural enemies; conduct regular field observations; and develop farmers as experts.

Growing a healthy crop requires basic agronomic skills like seed selection, soil preparation, planting and nursing/transplanting. Thus, the farmer must be conversant with the cropping calendar so that the crop potential could be achieved.

Three main areas of learning, namely work, interaction and empowerment, were emphasized in the training program.

Preserving natural enemies is a positive way of reducing pesticide use. To be able to do this requires the ability to recognize different factors in the crop ecosystem and to understand their interactions. This involves setting up zoos to enable the farmer to appreciate the difference between insect pests and the natural enemies (friendly insects). It also helps the farmer to appreciate the damage caused by blanket spraying of chemical pesticides.

Regular field observations concern learning how to make observations in the field. Observations are based on the collection and analysis of field data. In the learning situations, farmers used a formal process to gain these observational skills. In their own fields, these skills would be applied without the formality of the learning process. In so doing, they will become experts in their own farm operations, able to make inductive decisions from observations in the field.

The interaction involved the social aspects of IPM, such as motivating and helping other farmers to know and apply IPM or establishing IPM farmers groups.

Finally, the purpose associated with empowerment aspects of the training related to the developmental process necessary to enable farmers to identify factors which inhibit or hamper their lives and to find ways to resolve such issues. Farmers ought to discriminate between technologies made available to them by the research system and empower themselves to make their own decisions about their farm management activities so that they may employ the IPM principles that they have learned.

PARTICIPATORY ACTION RESEARCH (PAR) IN THE FARMER FIELD SCHOOLS

Participatory action research was aimed at providing farmers with analytical ability and skills to investigate the cause-effect relationships of local farming problems and thereby stimulate them to design a set of actions for solving problems in the field. It included insect zoo studies and field trials on crop protection and crop compensation (defoliation and detillering). On each project site, about 0.2 ha of irrigated plots were made available for FFS activities, i.e., field based experiential learning and participation action research. An overview of trials/activities is presented below.

CROP PROTECTION TRIALS: IPM VS. FARMER PRACTICE IN TRANSPLANTED RICE

Introduction

Results from the baseline surveys indicated that a greater percentage of farmers broadcast their rice. They spray their crops with rather expensive pesticides to control weeds, defoliators (leaf eaters) and detillers (stemborers). The cost effectiveness of this management method was unfavorable to farmers, as

derived benefits were very low and health hazards very high. The Asian IPM experience indicates that pesticide use could be reduced to zero in rice cultivation. The farmers conducted this trial to explore crop protection strategies and the possibility of no pesticide use under Ghanaian conditions.

Objective

To determine crop protection strategies which give the highest yield at lowest input costs.

Materials and Methods

A 0.2 ha plot was transplanted to rice by FFS farmers and the facilitators in two schools at each of the five irrigation sites. Ten rice varieties were used. Each FFS plot was further divided into two (0.05 ha each) for IPM practices and local farmers' practices (FP). A few farmers outside the FFS were selected for monitoring and comparing the use of inputs and yield results.

In the IPM plots, farmers made vital crop protection decisions as to whether to spray or not, based on weekly AESA. In the FP plots, farmers did routine pesticide spraying and fertilizer applications, based on traditional, local practices as reported during the baseline surveys. However, management practices, like fertilizer rates, irrigation, etc., were the same for both treatments. The farmers selected outside the FFSs were allowed to carry out their own management practices without any interference. Yield results for all three treatments were compared at the end of the program.

Results and Discussions

No insecticides were applied in the IPM plots, and weeds were controlled manually. In the local package plots, insect pests and weeds were controlled with pesticides as dictated by the spraying schedule.

On the irrigation project sites, higher average yields were obtained at the IPM plots (about 7 percent and 80 percent more than those of the FFS-FP and AFP plots, respectively) and the lowest at the actual farmers practice (AFP) farms, i.e., farmers operating outside the field school, except at Afife where there was serious damage due to birds. However, yields were not significantly different between the IPM and the FFS farmer practice (FFS-FP) plots.

The net returns, in terms of profit margins, followed the same trend as the yield data but the IPM plots recorded significantly greater average net returns (about 24 percent and 137 percent more than the FFS-FP and AFP plots respectively) in all cases, while the actual farmers practice plots recorded the lowest net returns (except Afife). However, the actual value of profit made, reflects the price differentials at the different locations. For example, while a bag of 84 kg paddy rice sold at 45,000.00 cedes at Ashaiman, it was sold for 28,000.00 cedes at Bontanga. This makes Ashaiman the most cost effective locality for rice production in the country. The comparatively higher yields recorded for the actual farmers practice (AFP) at Ashaiman and Tono indicate, among other things, higher standards of agronomic practices at these two sites than at Bontanga and Dawhenya. Ashaiman has the research wing of GIDA, and Tono comes under a better organized irrigation company, ICOUR, whose farmers are better taken care of than the others. The significance of bird damage to rice production was shown by the situation at Afife where, because the FFS plots were the only fields with rice crop within a large area, there was almost total destruction. Afife recorded negative net returns for all crop protection practices. This calls for serious efforts to intensify research bird control in rice fields.

While pesticides were used on the FFS farmer and actual farmer practices, no pesticides at all were used on the IPM plots. Thus, the greater increase in yield of IPM plots (when compared to actual farmer practices) and the higher net returns (as against both FP-FFS and FP actual) indicate that, in spite of higher labor costs, it is possible to grow rice and make positive economic returns without resorting to the use of pesticides, when the right agronomic practices are followed. The actual effect of this IPM training program on rice production is seen when data recorded from the actual farmer practice plots is compared to that from the IPM plots. This is because in actual farmer practices, in addition to the fact that land is not properly prepared and seeds are either broadcast or transplanted haphazardly, water is also not managed properly, and there are fewer visits to the farm. Therefore, less care and attention are paid to the crop.

In the farmers' practices established during the training program, land preparation, transplanting and water management were all the same as for the IPM plots. The only variation was the application of pesticide and the timing of fertilizer application. It is suggested, that in the future, farmers practices should be made to represent what farmers actually do, deriving from the baseline surveys. In this way, the true impact of good agronomic practices would be felt by the trainees directly during the course of the training as they compare their own traditional practices with the new improved practices.

It was also observed that initial soil analysis was not carried out to determine the actual levels of fertilizer required at the different sites prior to the FFS program. Thus, fertilizer rates determined and used were arbitrary and did not reflect the actual situation of the sites at the time of the training. In situations where the rates used were lower than the actual requirements, the potential yield of the crop would not be realized as was later observed for Tono and Bontanga. It is necessary, therefore, that future training programs should always be preceded with soil analysis to determine actual fertilizer requirements.

Seed availability was also a limiting factor that could have affected the results attained. At all the sites, seeds were obtained from old stock of farmers' collection, a practice which would not encourage farmer trainees to appreciate the need to look for good quality seed for planting. Despite these limitations, the data indicate that there was greater potential in the training methodology for increased rice production under irrigation in Ghana.

CROP COMPENSATION TRIALS (CTT) — DEFOLIATION AND DETILLERING

Introduction

Most rice farmers become unduly alarmed on observing crop damages on their fields due to insect pest attacks. The tendency is to apply pesticides outright without assessing the extent of damage or whether the crop is able to compensate. The rice crop is known to be very versatile in producing new leaves or tillers

to replace damaged ones (compensation). In fact the earlier training at Dawhenya in 1995 had demonstrated that defoliation up to 50 percent leaf area at active tillering and panicle initiation stages and up to 25 percent at heading caused no significant yield loss (Ketelaar, et al. 1995). Similarly, detillering trials at Dawhenya also had demonstrated that detillering up to 20 percent at active tillering stage, up to ten percent at panicle initiations stage, and up to five percent at heading stage does not reduce yield (Ketelaar, et al. 1995).

Materials and Methods

Eight 1m² quadrants (about 25 hills) were marked out on each FFS-IPM plot to impose the defoliation and detillering activities where pest damage on crops was simulated by cutting off portions of the rice plant.

In defoliation, four 1m² quadrants were used to impose two treatments (replicated twice) for control and 50 percent defoliation at active tillering stage, i.e., about 42 days after seeding (DAS). Plant height and tiller numbers were monitored weekly until harvest when the final average yield was determined from records of the two FFSs at each project site.

In detillering, four 1m² quadrants were used to impose two treatments (replicated twice) for control and 20 percent detillering also at active tillering stage (i.e., about 42 DAS). Tiller numbers were counted weekly till harvest when the final average yield was again determined from the two FFSs at each site.

Results and Discussion

Average yield values did not show any significant difference for the two treatments imposed in defoliation. Similarly, nonsignificant yield values were recorded for the two treatments imposed in the detillering trials. The farmer participants were very enthusiastic about these results.

The implication, therefore, is that pest damages at these levels may not cause any significant yield reductions and, therefore, may not justify the rushed application of pesticides as is currently done by farmers, because the rice crop is able to compensate.

OTHER STUDIES

Insect Zoos

Each FFS conducted studies on insects and spiders on caged rice plants using polythene as covers termed insect zoos. The objective was to determine: their functional behavior; whether certain insects (especially unfamiliar insects) were beneficial or harmful; and the life cycles of insects. The following cases were studied: spiders feeding on adult *Diopsis* and leaf hopper; dragon flies feeding on adult *Diopsis*; and rice skipper larvae maturing to adult moths.

The trials with the insect zoos did not meet expectations. Most of the cages constructed got damaged by wind when left in the field, or the insects died due to increased temperature in the cages. There is need to improve on the materials used for the cages.

Demonstration of Effects of Poultry Manure on the Growth of Rice

Equal portions of both IPM and FP plots of each FFS were treated with poultry manure at a rate of 2t/ha on 42/43 DAS (active to peak tillering stage). These were compared to the untreated plots. Vigorous plant growth was observed on the manure treated plots. The effect was well appreciated by farmers who indicated a desire to apply manure.

POPULATION DYNAMICS OF PESTS AND NATURAL ENEMIES AT DIFFERENT STAGES OF CROP GROWTH

The following trends recorded at the Ashaiman irrigation site for FFS 1 and 2 reflect the populations of insect pests and natural enemies with the crop growth stage at the different sites.

- At each FFS, more insects (both pests and natural enemies) were recorded in the IPM plots than in the FP plots.
- Fluctuations in pests and natural enemies were less in IPM than in FP plots.

- The trough points in FP plots (low pest and natural enemy number) indicate periods of insecticide applications.
- The IPM plots attained peak tittering earlier (about seven days) than the FP plots.

Weekly Attendance

The average weekly attendance trends at the FFSs on the five projects generally indicated an initial medium to high attendance (except Ashaiman), a mid season low and a late season high. Average attendance was generally good, ranging from 67.7 to 76.0 percent. The lowest initial attendance to FFS was observed at Ashaiman while the highest fluctuation in attendance was recorded at Afife.

The proportion of females to males was generally low for all the projects. However, there was more stability in female attendance than in males. Female participation at the FFS was higher in Afife than at the other project sites.

The enthusiasm shown by farmers and extension workers to participate in the field training activities is an equally good indication that Ghanaian rice farmers and extension workers can become willing partners to discover and implement IPM that works in the field. Some extension officers who had never entered the rice fields and only know how to deliver extension packages, willingly entered the rice fields and taught farmers how to grow a healthy rice crop. Similarly, farmers who rarely visited their fields regularly also learned to monitor their fields weekly, understand the rice ecosystem, reduce use of pesticides and manage their crops better.

At the policy level, the Ministry of Food and Agriculture provided substantial support and material inputs and engaged a local consultant to assist and monitor trained facilitators for the training programs. Though there were a few technical hitches and misconceptions at the initial stages of the program, the regional director-

ate was supportive of the projects towards the end. These are by themselves a clear indication of the government's commitment to the participatory IPM training methodology in the country.

It is envisaged that this participatory training methodology could be adapted into Ghana's extension delivery systems and extended to cover the training of the Ministry of Food and Agriculture's staff and farmers in the production of other crops in the country. In this direction, a workshop was conducted, bringing together scientists who are coordinating commodity research programs of the National Agricultural Research Project

(NARP) and the Research Extension Liaison Committees of the National Agricultural Extension Projects for briefing on the farmer field school concept and to discuss how to adapt it to our situation. At the end of the workshop, it was recommended that the training program

The enthusiasm shown by farmers and extension workers to participate in the field training activities is an equally good indication that Ghanaian rice farmers and extension workers can become willing partners to discover and implement IPM that works in the field.

should be adapted into the extension delivery system and that pilot programs on crops which depend on pesticides and with considerable scientific and technical information available be established. Consequently, the following crops have been selected as targets for this pilot program: vegetables (tomato, okra, garden eggs, and cabbage), cowpea, cotton, pineapple, plantain, maize (storage), and rice (upland and valley bottom). IPM-FFS has actually started on cowpea under the Collaborative Research Support Project (CRSP) cowpea programs.

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Government Initiatives for Domestic Capacity Building for Commercialization and Transfer of Agricultural Technology in Africa by Simone Noemdoe, National Community Development and Program Designer, Land Reform Unit, Rural Foundation, South Africa

Abstract

Country specific and public sector development priorities impact profoundly on the strategies adopted. In the South African context, for example, reconstruction and development programs focus on poverty alleviation, equity and economic growth as primary concerns. With respect to public sector policies and investments, a preference for specific types of growth is inevitable.

The contemporary trend of favoring economic liberalization places commercialization at the center stage of the macroeconomics scene. The heterogeneity of the rural agricultural sector warrants due sensitivity to demand side complexities and these cannot be simply addressed by free market commercialization.

The fit is best when macro policies target agricultural technologies and allocate resources which enhance the asset base and output of the resource-poor producers.

Politics bedevils the entire spectrum of variables mentioned above. Resource-poor farmers seldom command the political clout to influence decisions in their favor. Technically, resource-poor producers are ill equipped to adjust to favorable market signals. These considerations complicate the preferred role of the public sector at both the technological and commercial levels of intervention. The key challenge for the government is the establishment of a more diversified rural economy which will enhance the labor absorption capacity of the rural economy, stimulate increased economic growth, create a more equitable distribution of economic assets, broaden the range of economic activities by sector and commodity type, widen the range of enterprise types by scale and market share, and fashion institutional support services which are sensitive to the labor market, enterprises, commodities and household needs.

The public sector will also have to address the basic social infrastructure needs of impoverished households and communities. Such an initiative is currently being developed under the auspices of the Ministry of Agriculture and Land in South Africa. Through public sector intervention, donor finance will be transferred to the Damara Land Use Consortium which comprises the following development partners:

- Agricultural Research Council — a public sector institution where research services provided are geared toward technology development of mostly large commercial farmers;
- African Farmers Union — an apex body of village/rural settlement farmers' associations which have been disadvantaged and have no access to any of the factors of production;
- Rural Foundation — a national service provider in rural development which facilitates the development of appropriate institutional capacity at the village level;
- Center for Sustainable Agriculture — where low input sustainable agricultural (LISA) technologies and farming systems are being developed and field tested;
- Center for Rural Research and Development — a non-governmental agency which is responsible for the development of financial management and administration systems which will ensure the effective and efficient adoption of technologies transferred; and
- Department of Agriculture — ultimately responsible for the continued development of technologies and their transfer in an equitable manner.

This consortium is one of the first examples of a complete synergy in the delivery of services between the public, private and nongovernmental sectors. It is being developed at almost no institutional cost to the public sector. This partnership initiative will facilitate a critical component in the democratization and decentralization process, i.e., promote responsibility, control, ownership, commitment, and risk taking in the implementation of development programs.

Institutional development strategies and policies are generally fashioned by supplier type institutions such as powerful public and private sectors and international institutional actors. This has resulted in the lack of developmental impact due to lack of involvement of the targeted consumer/beneficiary. Public sector investments in skills training (human capital) and institutional capacity building (organizational capital) programs of local beneficiary groups is imperative if the development void identified above is to be addressed. Carefully targeted pilot programs involving specific social groups (women) and sectoral

programs like rural finance have demonstrated the efficacy and sustainability of this approach.

Successful rural development cannot happen without a well developed agricultural sector, however, agriculture is not the only sector which can endure sustained growth. It is influenced by the promotion of investments in micro enterprises which will locally enhance the value of products, the regional production of non-tradable goods and services demanded by agriculture as inputs to capture the expendable income of agriculture, and the production of regionally tradable goods to enhance the decentralization of industry.

Finally, in the creation of capacities which will enable the commercialization, development, transfer and absorption of agricultural technologies, there should be a careful structuring of the varied opportunity mixes, i.e., by whom, with whom and with what degree of responsibility and risk pooling and/or sharing.

Theme V: Summary of Discussions

Chair: Emmanuel Acquah, Director of International Programs, UMES, USA

Rapporteur: Coffi Prudencio, Regional Senior Agricultural Economist, REDSO/WCA, Côte d'Ivoire

Moderators: Emmanuel Atayi, Coordinator of Eco-regional Programs, IITA, Nigeria; Taye Bezuneh, International Coordinator, SAFGRAD, Burkina Faso; Joseph Fajemisin, Research Liaison Scientist, IITA, Bouake, Côte d'Ivoire; W.A. Amponsah, Associate Professor, North Carolina A&T University, USA; and Sam Muchena, Managing Director, ACFD, Zimbabwe

Reporter: Simone Noemdoe, National Community Development and Program Designer, South Africa

Workshop participants examined several cases in which partnership initiatives facilitated technology transfer and commercialization.

The Farmers' Field School in Ghana illustrates a partnership that brings together several disciplines in participatory, action oriented research. A Burkina Faso project partnered farmers, agronomists, local scientists and artisans with the Sustainable Energy Center in providing solar energy for the post-harvest storage of potatoes. Both partnerships used a holistic approach to research and extension.

Major issues in partnership development include the need to reduce donor dependency while sustaining research, problems with existing governmental cultures that lack openness, accountability and transparency, difficulties in defining the respective roles of partners, the need for new ways of thinking to accommodate the realities of an increasingly changing global market, and lack of awareness of the activities and comparative advantage among potential partners.

In situations limited by poor infrastructure and a meager resource base, a process approach is needed to integrate institutional components such as research, extension, and credit. Cross-border information sourcing

and collaboration in local-level partnerships provide viable opportunities to enhance technology development, transfer and commercialization.

Experience shows that innovative partnership development requires institutional commitment, catalytic leadership and sustainable funding.

One mechanism for sustainable funding is for government and private sector entities to match donor support in establishing endowments from which accruing interest can be used to sustain funding for technology transfer and commercialization.

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transfer and commercialization.

RECOMMENDATION

- Agricultural research systems, in collaboration with donors, should develop mechanisms to facilitate partnerships among inventors, manufacturers, end-users, and financial institutions to promote commercialization. Mechanisms should include the clear definition of partner roles and benefits and transparent norms. Experiences and lessons learned should be documented and disseminated widely.

7. Regional Recommendations

Chair: Coffi Prudencio, Regional Senior Agricultural Economist, REDSO/WCA, Côte d'Ivoire

Moderators: Peter Katjavivi, Vice Chancellor, University of Namibia, Namibia (East and Southern Africa); and S. K. Reddy, Assistant Director, REDSO/West and Central Africa (WCA), Côte d'Ivoire

Reporter: Kwesi Attah-Krah, Network Coordinator, ICRAF, Nairobi, Kenya

On the final day of the workshop, participants from the two regions (West/Central, Eastern and Southern Africa) met to address all of the five themes and establish regional priority recommendations. Since the recommendations for the two groups were similar, they are presented jointly.

PREAMBLE

We, the participants from sub-Saharan Africa, having met at Accra, Ghana, 4-7 November 1996:

- noting the important role of commercialization and transfer of agricultural technologies in the sustainable development of our regions;
- convinced that commercialization and transfer of agricultural technologies requires the urgent establishment of an enabling political and economic environment based on coherent policies and supportive institutional structures;
- recognizing the need to generate customer-focused technologies by determining and documenting successful approaches for generating demand-driven sustainable agricultural technologies;
- appreciating the importance of creating viable and mutually beneficial mechanisms for sharing technology;
- noting that input markets continue to impede access to inputs by most of the farmers in our regions, leading to threatened food security and degradation of natural resources;

- agreeing on the importance of establishing partnerships between all stakeholders to support and finance innovative approaches to development, commercialization and transfer of agricultural technologies, through partnerships between and among agents of development; and
- further convinced of the need to build capacities and capabilities, through training and other means of all stakeholders to take advantage of the opportunities that arise from successful development, commercialization and transfer of agricultural technologies, make the following recommendations.

REGIONAL RECOMMENDATION 1

Mechanisms for establishing sustainable funds (i.e., endowment, ear-mark taxes) for research, development and commercialization of agricultural technologies at national and regional levels should be established.

Process: Who should take the initiative?

- NARSs should take the initiative by working with their respective governments to create the enabling environment (i.e., legal framework) to set up the system(s).
- The mechanisms should be created based on sub-sector or commodity approaches.
- Stakeholders (private firms, farmer associations, producer associations, NGOs, etc.) should play a paramount role in the management of the fund.

- Activities to be supported by the fund should be demand-driven or customer-focussed.

Creation of the Mechanism

Stakeholders, in collaboration with donor agencies, should create the mechanisms for a country or a region.

Management, Operation, and Sustainability of the Fund

Issues of sustainability should be given prominence in developing the operational and management structures for the fund.

Specific Actions

Building from ongoing experiences and lessons learned, it is recommended that African research leaders, through their respective regional organization (CORAF, SACCAR, ASARECA), discuss and develop a proposal for the establishment of sustainable funds, initially in two or three countries per region. The proposal should be submitted to donors, government, and private sector for consideration.

Follow-up

It is recommended that USAID/PSGE provide the necessary follow-up support for the specific action to be taken.

REGIONAL RECOMMENDATION 2

Partnerships should be formed throughout the food system continuum (input/on-farm/post-harvest) to facilitate access to and increase utilization of critical inputs (seed, fertilizer, credit, etc.) and information.

Process

Regional organizations or centers should provide initiatives to foster regional partnerships which include national agricultural research institutes (NARIs), private sector, traders, NGOs, farmer associations, etc. An example of activity to be undertaken could be “training for improving business and management skills for agricultural enterprise development.” Partnership in this case could be the African Center for

Fertilizer Development, fertilizer businesses, local traders and private businesses. The ultimate goal would be to increase access to and use of fertilizers and other inputs by small and medium enterprises. Partnership between universities, research centers, NGOs and local farmers should be created.

Specific Action

It is suggested that USAID and/or other donors consider the possibility of providing seed grants to support such initiatives.

REGIONAL RECOMMENDATION 3

An enabling environment should be created to facilitate the development and commercialization of technology among all partners.

Process: Who should take the initiative?

NARSs should take the initiative, in collaboration with stakeholder/partner coalitions throughout the technology continuum.

Specific Actions

USAID/PSGE should collaborate with SPAAR to ensure that NARSs and stakeholder organizations continue to bring the issue to the attention of member country authorities.

REGIONAL RECOMMENDATION 4

Existing regional organizations should expand their capacity for gathering, disseminating and sharing critical information, training and networking to facilitate the commercialization of technologies.

Process: Who should take the initiative?

Regional organizations (SACCAR, CORAF, and ASARECA) should take the initiative. They should work collaboratively with donors, SPAAR and stakeholders. The major stakeholders should include the private sector, commodity groups, and appropriate ministries.

Specific Action

Regional institutions and their associated NARSs should develop proposals for creating such capacity and submit them to the donor community for consideration and support.

REGIONAL RECOMMENDATION 5

Baseline data should be gathered on the legal and regulatory framework for intellectual property rights in African countries.

Specific Action

USAID/PSGE or another donor should consider the possibility of funding three regional studies to analyze the state of IPR, and make specific recommendations to the three regional organization (SACCAR, CORAF, and ASARECA).

REGIONAL RECOMMENDATION 6

The existing system of TDT monitoring, evaluation and impact assessment(s) at national and sub-regional levels should be strengthened and expanded.

Process: Who should take the initiative?

NARSs, in collaboration with regional organizations

(SACCAR, ASARECA, CORAF, SAFGRAD, INSAH, etc.), should provide leadership to initiate this recommendation.

Specific Action

Ex-ante, demand-driven, commodity sub-sector analyses should be conducted to provide the benchmark for effective impact assessments.

Follow-up

USAID/PSGE, other donors and SPAAR should be encouraged to continue supporting strategic planning and impact assessment in SSA, but the focus should be on commercialization of off-farm technologies.

REGIONAL RECOMMENDATION 7

It is strongly recommended that appropriate follow-up action should be taken to ensure that the momentum generated at the Accra workshop is not lost, given the high interest on workshop themes throughout SSA.

Specific Action

Participants suggest that USAID and USDA develop an appropriate activity to ensure that the momentum continues.

8. Closing Session

Comments by Honorable Dr. Christine Amoako-Nuamah, Minister of Environment, Science and Technology, Ghana

The Honorable Dr. Christine Amoako-Nuamah:

Hon. Johnson Nkuuhe, Member of Parliament, Uganda, Mr. Myron Golden, USAID Mission Director to Ghana, Mr. David Atwood, Division Chief, USAID/PSGE, Washington, D.C., Dr. S.K. Reddy, Assistant Director, USAID/REDSO, Office for West and Central Africa, Dr. Jacques Eckebil, FAO Deputy Regional Representative for Africa, ladies and gentlemen:

I am indeed honored to chair the closing session of this important Workshop on a topic which is central to all our economies in sub-Saharan Africa. To successfully transform our agricultural sector to serve as the engine for economic development, transfer and commercialization of our agricultural technologies in Africa should be given greater attention.

This workshop has provided a unique forum for very meaningful dialogue among Africa-based stakeholders. You have produced recommendations that national, regional, and international systems and our development partners (the donor community, FAO, etc.) should review and use in efforts to commercialize and transfer agricultural technology. I request the organizers of the workshop to ensure that these recommendations are made available to all appropriate

government and nongovernment organizations, the private sector, and donor communities.

Our task now is to provide leadership within our countries and regional groups (i.e., CORAF, ASARECA and SACCAR) and collaborate with the donor community to ensure that the outcome of this very important meeting is translated into concrete

actions and does not sit on the shelves of offices and libraries gathering dust. On our part, my colleague, the Minister of Food and Agriculture, and I are committed to ensure that your recommendations, which are consistent with our national development thrust, will be discussed with our development partners in the immediate future to develop plans to implement them.

My government is pleased that Ghana was selected as the host country for this important

meeting. We thank USAID, the United States Department of Agriculture (USDA) and the University of Maryland Eastern Shore (UMES) for organizing such a successful workshop.

To our brothers and sisters who traveled to Ghana, we wish you safe trips back home.

This workshop has provided a unique forum for very meaningful dialogue among Africa-based stakeholders. You have produced recommendations that national, regional, and international systems and our development partners (the donor community, FAO, etc.) should review and use in efforts to commercialize and transfer agricultural technology. I request the organizers of the workshop to ensure that these recommendations are made available to all appropriate government and nongovernment organizations, the private sector, and donor communities.

Comments by Mr. David Atwood, Division Chief, USAID/AFR/SD/PSGE; Myron Golden, Director, USAID/Ghana; and Jacques Ekebil, Deputy Regional Representative, FAO

Brief comments were made by each of the above officials during the closing session. Unfortunately, no written records were available to be included in the proceedings. The editors sincerely apologize for the omission of these important comments and hope that the participants have benefited from the comments.

*Vote of Thanks by Dr. Bakary Kante, Director of Environment Division,
Ministry of Environment, Senegal*

Dr. Bakary Kante: Madam Chairperson, Ladies and Gentlemen:

As we finish up our work, on behalf of the assembled participants, I would like to thank USAID and the Ministry of Food and Agriculture of Ghana for sponsoring the Workshop as well as USDA, UMES, and AMEX International, Inc. who participated as collaborators and coordinators. Mr. Chairman, the government and the people of Ghana spared no effort to make our stay the most fruitful and agreeable.

The logistics provided for our meeting, the kindness and the availability of our hosts contributed to a resounding success of our work. Once again, I would like to extend our profound gratitude to the people of Ghana.

Mr. Chairman, ladies and gentlemen, my colleagues asked me to convey a special gratitude to USAID for taking the initiative to organize and facilitate the participation of Africans in this exercise to help our continent in achieving a sustainable development. All of us have been impressed by the competence, availability, and courtesy of the USAID contingent. Thank you once again.

Lastly, this meeting could not have succeeded if a dynamic and competent team, with a tremendous love of Africa, had not prepared the working documents. The UMES team showed a rigorous expertise throughout the proceedings of our meeting, which warrants our admiration. Through me, all my African colleagues say thank you.

Long live international cooperation, long live USAID.

Remarks by the Honorable Dr. Johnson Nkuuhe, Member of Parliament, Uganda

The Honorable Dr. Johnson Nkuuhe: Distinguished delegates, workshop organizers and facilitators, ladies and gentlemen:

It gives me great pleasure to make a few remarks at the close of this successful workshop on “Commercialization and Transfer of Agricultural Technology in Africa.” I would like to thank those who made this workshop a success.

EXPECTATION AND ACHIEVEMENTS

Although we did not spend time discussing expected outcomes of the workshop, they were provided to us by the organizers in the workshop agenda. The purpose of the workshop was to provide a forum for dialogue among Africa-based stakeholders in order to produce viable recommendations that national and international systems and the donor communities can use to accelerate access to and use of agricultural technologies through commercial or private sector means. I am sure you all agree with me that this purpose was achieved.

During the last four days, we discussed the five workshop themes.

On the first theme, *Enabling Environment*, we identified the constraints and opportunities that affect transfer and commercialization of agricultural technologies. We discussed the four “I’s” (*infrastructure, institution, investment, and incentives*) with the assistance of W. A. Amponsah. I thank all who presented papers under this theme: Acquah, Gelaw, Maredia, Amponsah, Wagonda-Muguli, Roland Pearson, Pierre Nkepnang, Kamau, Alhassan, Brink, and John Mubiru.

We examined the second theme, *Generation of Customer-focused Technologies*, and determined approaches for generating these technologies. Once again I thank the paper presenters.

The third theme was *Sharing of Technologies*. We identified viable mechanisms to facilitate the sharing of technologies within and among countries. Under this theme, we made various recommendations on intellectual property rights and information sharing, with good examples in telematics and other computer-assisted information technologies.

On the fourth theme, *Access to Inputs*, we identified and recommended ways to improve input markets to promote the availability, access and use of inputs. We focused specifically on seed and planting materials, fertilizers, pesticides, post-harvest processing, and livestock-related technologies.

On the final topic, *Innovative Partnership Development*, we successfully identified and recommended non-traditional and innovative approaches to technology transfer and commercialization through partnership initiatives between and among traditional and non-traditional agents of development. We looked at sustainable funding initiatives in Uganda, public and private sector partnerships in rural Maryland, institutional innovations in farmers’ field schools in Ghana and government initiatives in South Africa.

Finally, we heard about endowments. We exchanged ideas. Networks and friendships are established for future collaboration and partnerships. We saw partnerships in action, e.g., the Government of Ghana, USAID, USDA, UMES, AMEX International, Clarkson Systems and others that are not mentioned here. Many lessons were learned.

Technology should be client oriented, demand-driven, environmentally friendly and socially acceptable.

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We heard new phrases:

- winds of change in Africa;
- managing director and management directors;
- technical know-how and technical know-who;
- hakuna matata; and
- the proper way to end a long speech finally, in conclusion, to end it all.

In conclusion, the way forward has been covered in the recommendations. The challenge to us is to go back and implement and facilitate the commercialization and transfer of agricultural technology.

In conclusion, the way forward has been covered in the recommendations. The challenge to us is to go back and implement and facilitate the commercialization and transfer of agricultural technology.

With these few comments, I declare this workshop officially closed. Thank you.

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